Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

TECHNOLOGY DEPT.

JANUARY, 1959

PUBL... JAN 29 ...

CLEANING AND ANNEALING LINES

Designed and Built by MESTA

MESTA 2000 FPM Continuous Cleaning and Annealing Line for Steel Strip in Tin Plate Gauges with Pay-Off Reels, Mash Welder and Tension Reels in Operation at Weirton Steel Company, Division of National Steel Corporation.

Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

From iron ore to iron

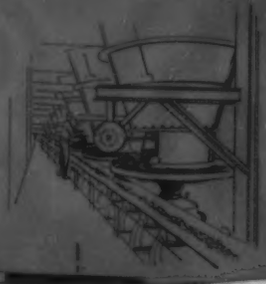
Cutler-Hammer Control sets the pace at USS Fairless Works

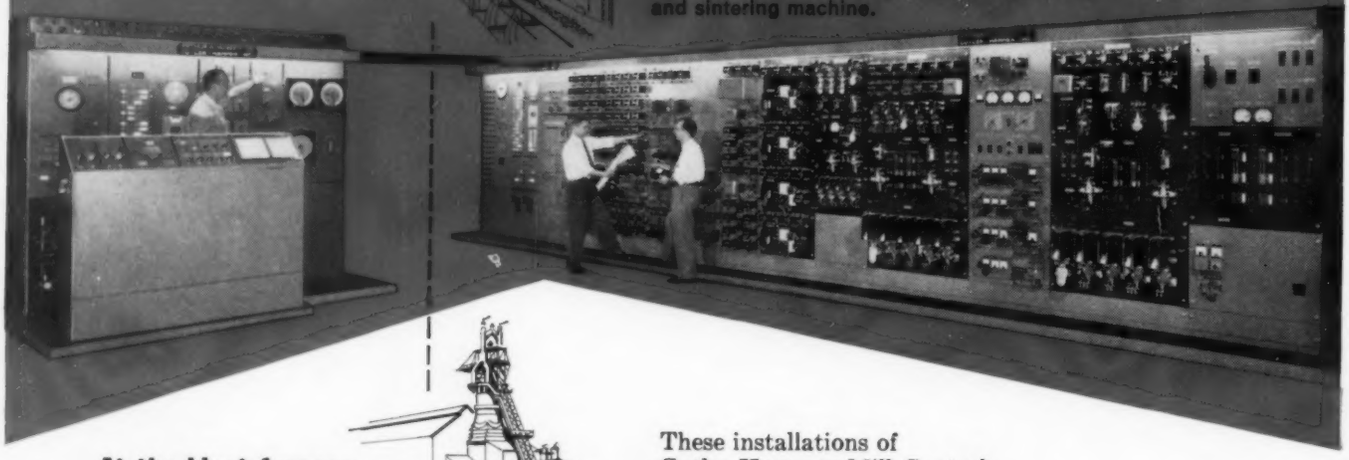
At the ore docks—

Cutler-Hammer Constant Voltage D-c Control directs and protects the operation of the two mammoth ore unloaders and the two ore bridges. Here Cutler-Hammer applied the exclusive Wilson Ritchie emergency dynamic braking control, "Speed-Distance" end zone protection, and bucket protection against overhoisting and excessive cable pay-off.

At the sintering plant—

The highly efficient operation of the Fairless Works sintering plant is a result of the combined engineering talents of Arthur G. McKee, U. S. Steel, and Cutler-Hammer. Cutler-Hammer Unitrol® centralizes the A-c auxiliary controls, and the Magnetic Amplifier Type D-c Adjustable Voltage Drives coordinate the operation of the conveyor type tables, feeders, pug mill, balling drums, and sintering machine.





At the blast furnace—

The new automatic blast furnace charging system is another joint development of Arthur G. McKee and Cutler-Hammer. This revolutionary system completely integrates the proper proportioning and charging of the furnace to follow a pre-selected schedule. Extensive use of visual signals provides a continuous check on the position of the skip cars, number of load on the small and large bells, stock rod position, top temperature and pressure.

These installations of Cutler-Hammer Mill Control quickly demonstrate the very broad experience and engineering knowledge available to you in the solution of your mill control problems. Write today describing your particular requirements . . . your letter will receive prompt attention. Dept. A-232 Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

CUTLER-HAMMER CONTROL

Look to Cutler-Hammer mill experience . . . as broad as it is long

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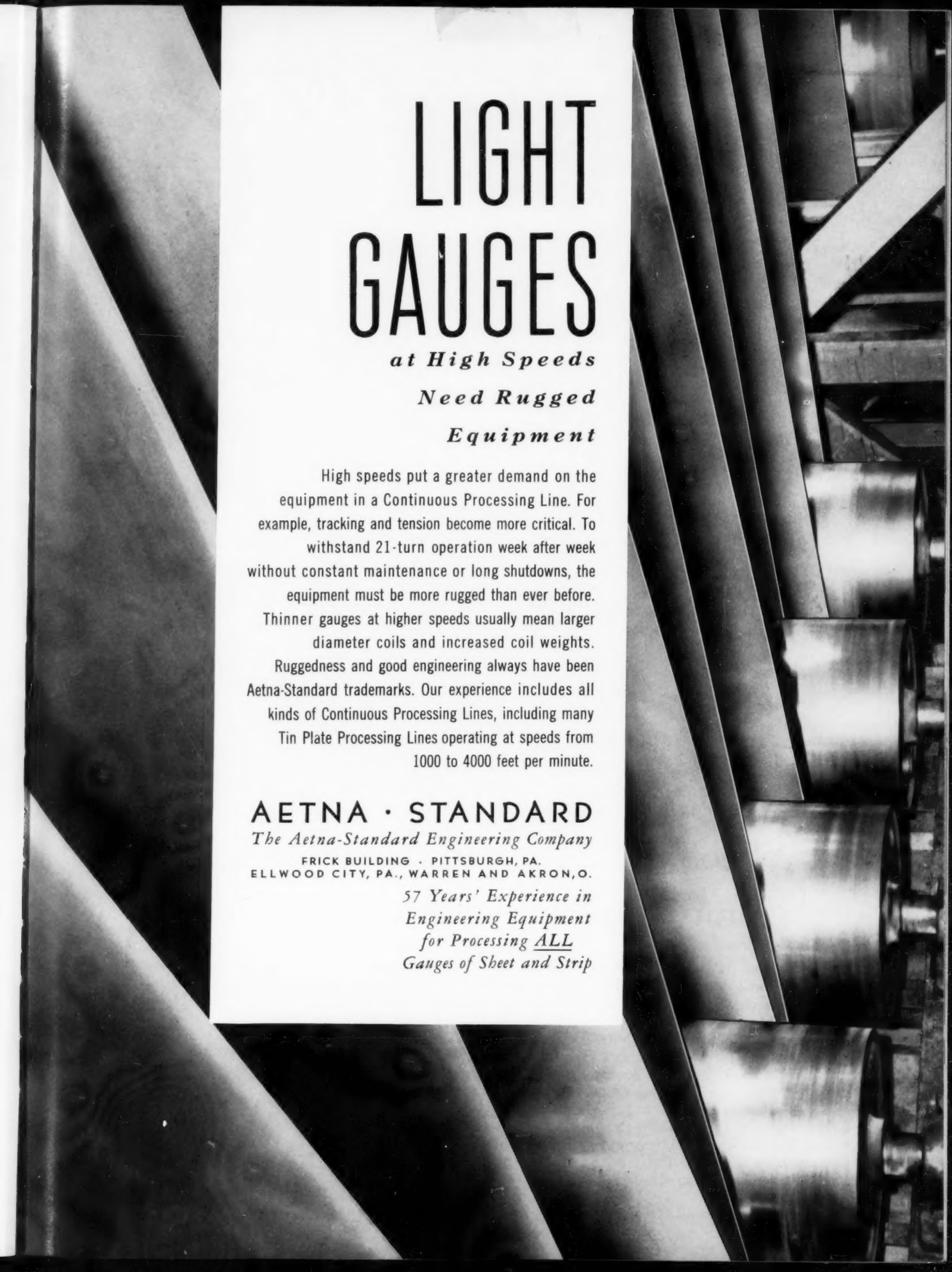

LIGHT GAUGES

at High Speeds

Need Rugged

Equipment

High speeds put a greater demand on the equipment in a Continuous Processing Line. For example, tracking and tension become more critical. To withstand 21-turn operation week after week without constant maintenance or long shutdowns, the equipment must be more rugged than ever before. Thinner gauges at higher speeds usually mean larger diameter coils and increased coil weights. Ruggedness and good engineering always have been Aetna-Standard trademarks. Our experience includes all kinds of Continuous Processing Lines, including many Tin Plate Processing Lines operating at speeds from 1000 to 4000 feet per minute.

AETNA · STANDARD

The Aetna-Standard Engineering Company

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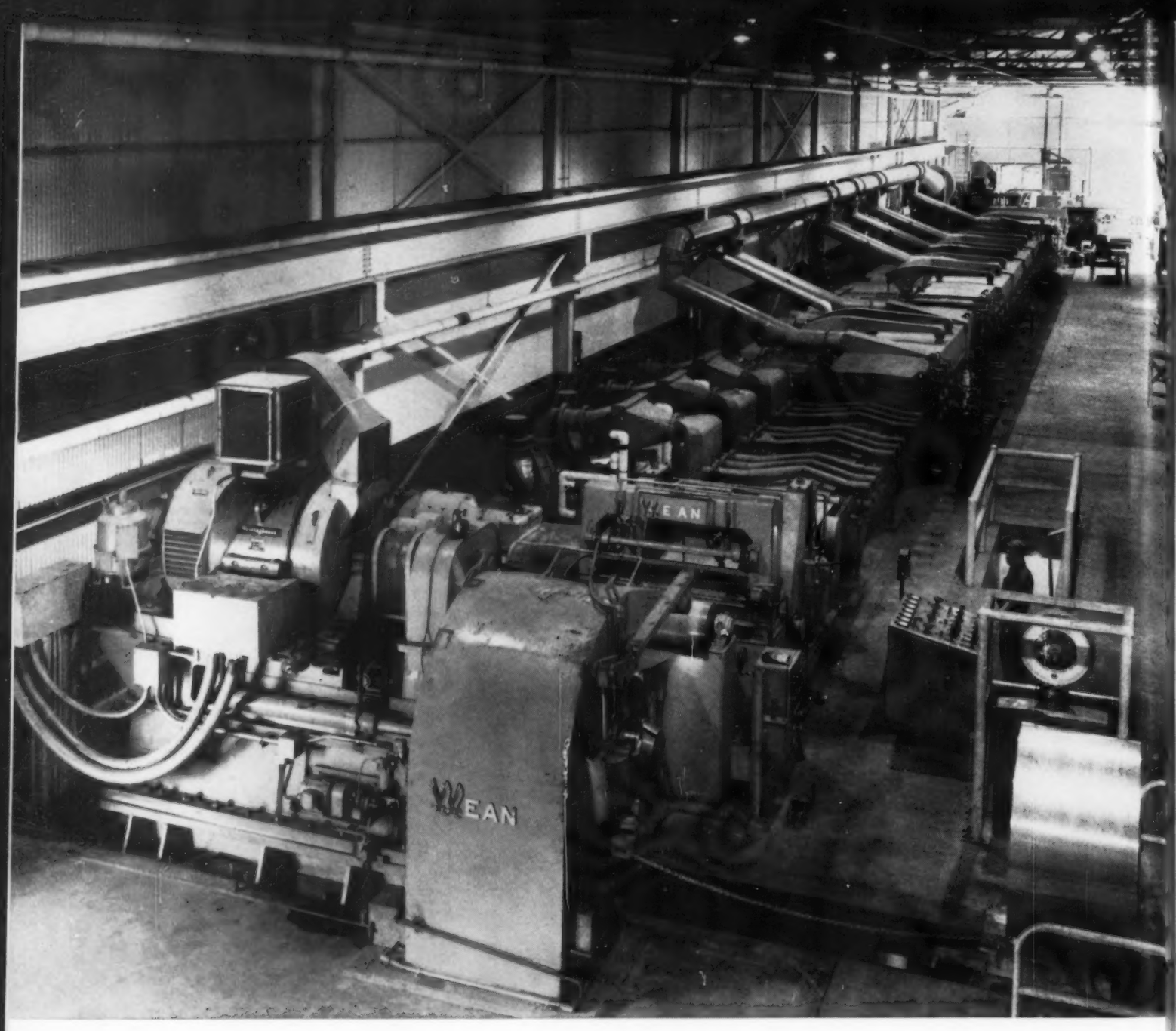
57 Years' Experience in Engineering Equipment for Processing ALL Gauges of Sheet and Strip



Wheeling Steel cleans tin plate faster, more efficiently with Wean Line

The new Wean tin plate cleaning line at Wheeling Steel's Yorkville plant is an excellent example of modern electrolytic cleaning techniques. Grid-type current application above and below the moving strip permits line speeds to 2000 feet per minute with complete palm oil removal. Through Wean's tension-type design, with automatically controlled "floating" mandrel, accurate strip tracking is assured at all line speeds. This design also eliminates the floor space previously required for exit-end looping. Coils up to 24 tons, in widths from 18 to 45 inches and all usual tin plate thicknesses, can be handled by the line.

Wean has pioneered in the design and development of electrolytic cleaning processes: has built 80% of all lines in use today. This experience plus Wean's *creative engineering* ability can benefit you, whatever your requirements for continuous steel processing lines.

WEAN

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Iron AND Steel ENGINEER

Volume XXXVI · Number I **JANUARY 1959**

67 Mechanical Manipulation in Bar Mills
by E. C. Peterson

79 A Constant Horsepower Computer-Permitting the Use of Slip Couplings for Winder Drives
by P. R. Gravenstreter

84 The President's Message

86 1959 AISE Officers and Directors

89 1959 AISE National Committees

91 Immersion Thermocouple Practice
by H. V. Schubert

98 Current AISE District Section Meeting Notices

99 Statistical Computations Increase Production
by Dr. Melvin J. Greaves

103 The Air Pollution Situation Today with Special References to Control Legislation
by Allen D. Brandt

Mechanical Inching Drives Symposium
109 Application and Operational Aspects
by H. Kermit Fish

110 Engineering Aspects
by Dr. J. R. Shields, E. W. Barth, K. W. FitzSimmons

112 Developments in the Iron and Steel Industry During 1958
by I. E. Madsen

DEPARTMENTS

11 Crops and Shorts
21 Patent Reviews
47 Foreign Digests
163 Date-line Diary
167 Industry News
171 Publication Service
179 Personnel News
191 Equipment News
199 Book Reviews
203 Index to Advertisers

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ANOTHER OF THE MOST MODERN BRIDGES EVER BUILT

Now for *Great Lakes Steel* by **Heyl & Patterson**

Known as No. 13 on Zug Island, the Bridge shown here is the most modern bridge on the island; in fact, it is one of the largest and most modern bridges anywhere . . . for Boat Unloading, Stocking and Reclaiming Ore.

The listed features represent the combined thinking and experience of the engineers of **Great Lakes Steel Corporation, Division of National Steel Corporation, and Heyl & Patterson:**

- Adjustable voltage control for smooth bridge, trolley and bucket operation . . . for increased hoisting speed . . . for reduction of trolley weight . . . for drastically lowered power consumption.
- H & P Special Bucket Twister for turning bucket in hold of vessel.
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- Worm Gear Driven Trucks that are fully equalized.
- H & P Automatic Hydraulic Rail Clamps for Bridge safety.
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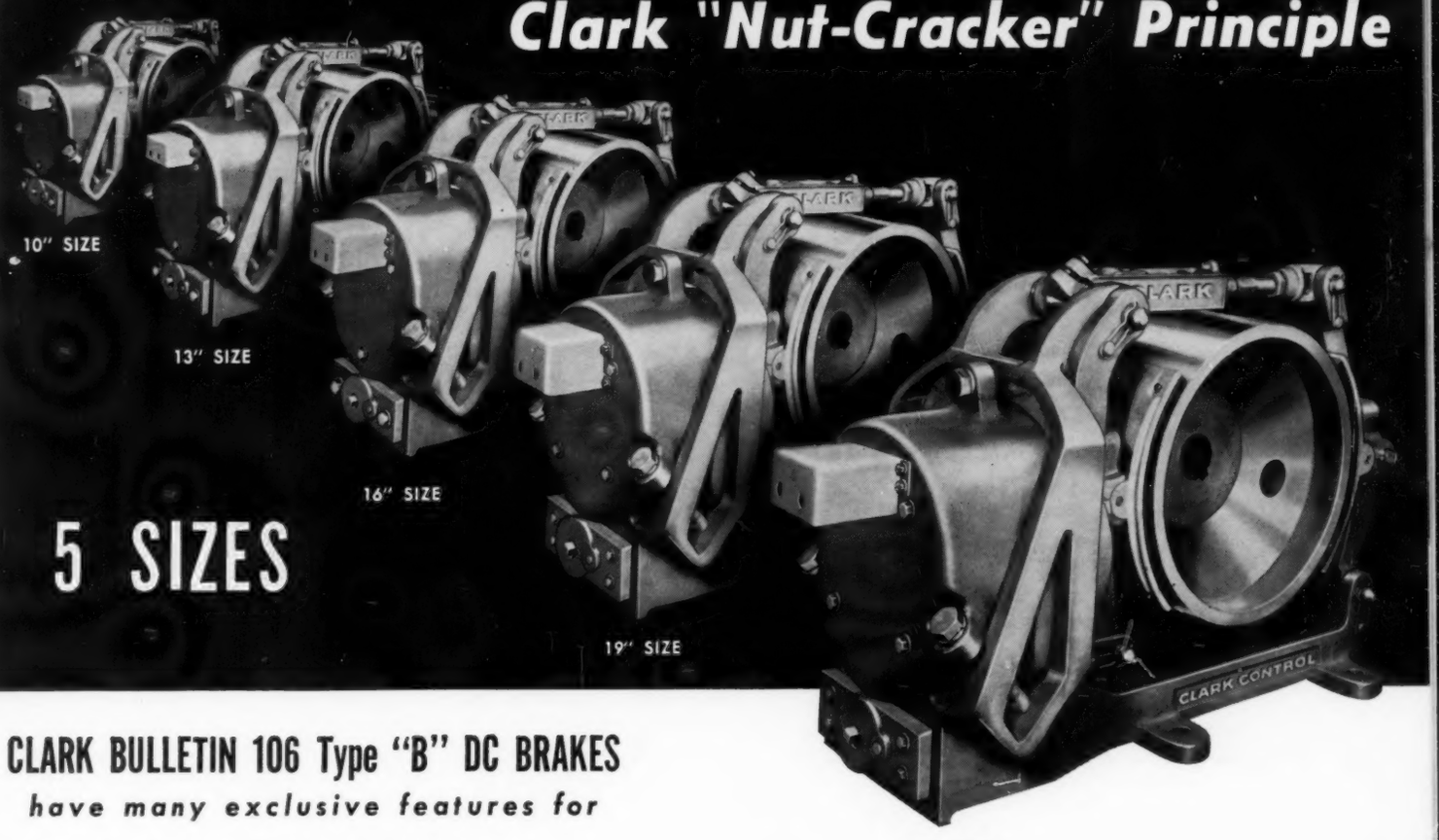
CLARK offers a New, Improved Line of AISE-NEMA BRAKES . . . *with the proven Clark "Nut-Cracker" Principle*



5 SIZES

CLARK BULLETIN 106 Type "B" DC BRAKES

have many exclusive features for

- MORE DEPENDABLE OPERATION
- EASIER MAINTENANCE
- GREATER SAFETY

Built to AISE-NEMA standards for use with 600 series mill motors, this new line achieves economies in size without sacrificing ruggedness. These brakes retain the famous Clark "NUT-CRACKER" principle which has proved successful on heavy-duty industrial applications over many years. It assures more dependable operation and longer lining life by providing equal distribution of shoe pressure on the brake wheel. Simplicity of mechanical operating linkage means fewer parts to maintain and simpler adjustments.

FEATURES

- All maintenance adjustments made from the top.
- Single adjustment for air gap. Built-in indicator.
- Magnet case and coil easily removable and replaceable without disturbing brake adjustment or releasing brake.
- Coil replacement easily done on the job. Epoxy encapsulated coils.
- Simpler and easier shoe replacement.
- Wheel and motor armature easily removable as a unit without disturbing brake adjustment.
- Equal distribution of shoe pressure for more positive braking.
- Self aligning shoes for even distribution of lining wear.
- Torque setting unaffected by lining wear. Built-in torque indicator.
- Cast-steel construction throughout.
- Nitralloy bushings with hardened pins.
- Captive hairpin cotter retainers at all pivot points.

For Complete Information Write for Bulletin 106 B

The **CLARK CONTROLLER** *Company*

Everything Under Control

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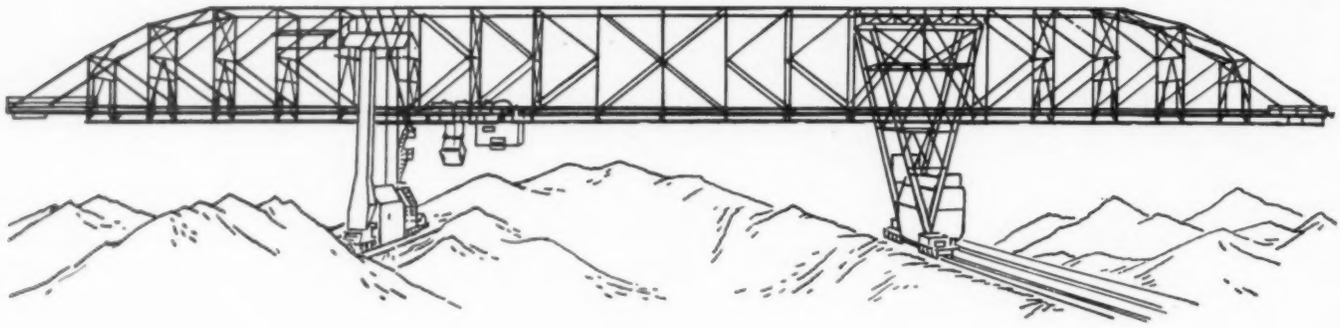
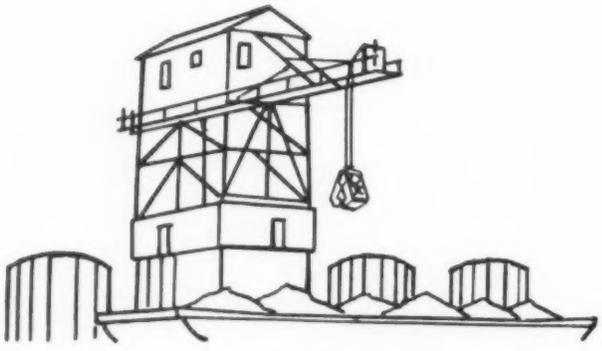
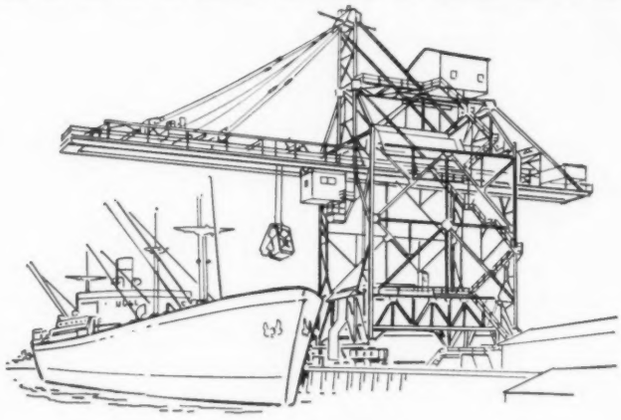


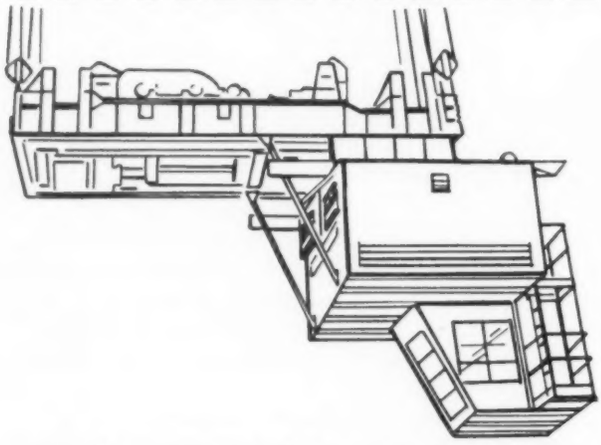
ore and coal bridges



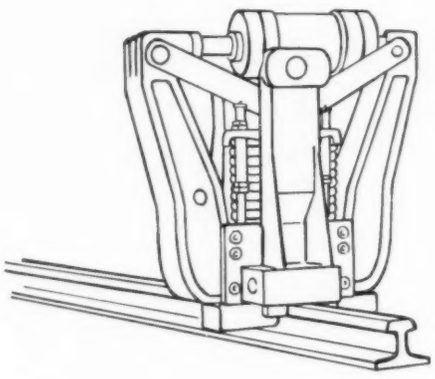
coal unloaders



ship unloaders



replacement man trolleys



Gale-Guard rail clamps

DRAVO

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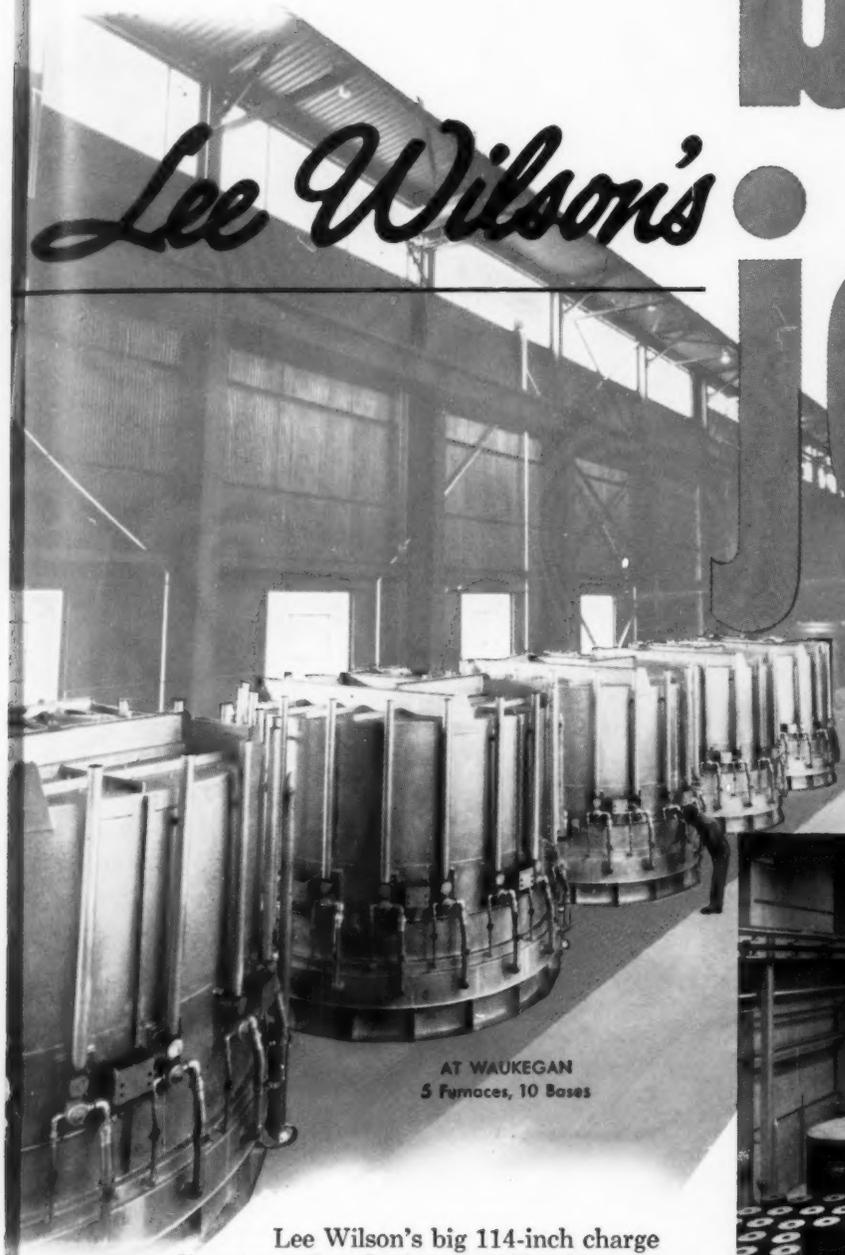
FOR MORE INFORMATION, CONTACT: DRAVO CORPORATION • PITTSBURGH 25, PENNA. • SP. 1-1200

Lee Wilson's 'big jobs'...

give American Steel and Wire greater productivity, better Rods and Wire



AT WAUKEGAN
5 Furnaces, 10 Bases

AT CUYAHOGA WORKS 6 Furnaces, 12 Bases

Lee Wilson's big 114-inch charge diameter rod and wire annealing furnaces give American Steel and Wire both the speed and quality they require to meet modern-day competition.

The largest furnaces of their type ever built, they will easily take four spiders of heavy rod in a single charge. A high convection system that sends 5 million BTU's per hour is controlled with exacting precision from a central control area.

If you're considering investing in new wire annealing equipment, make certain you check first with Lee Wilson—America's most experienced wire and rod annealing equipment manufacturer.

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HIGH CONVECTION ANNEALING FURNACES.
MAKE THE BEST METALS BETTER

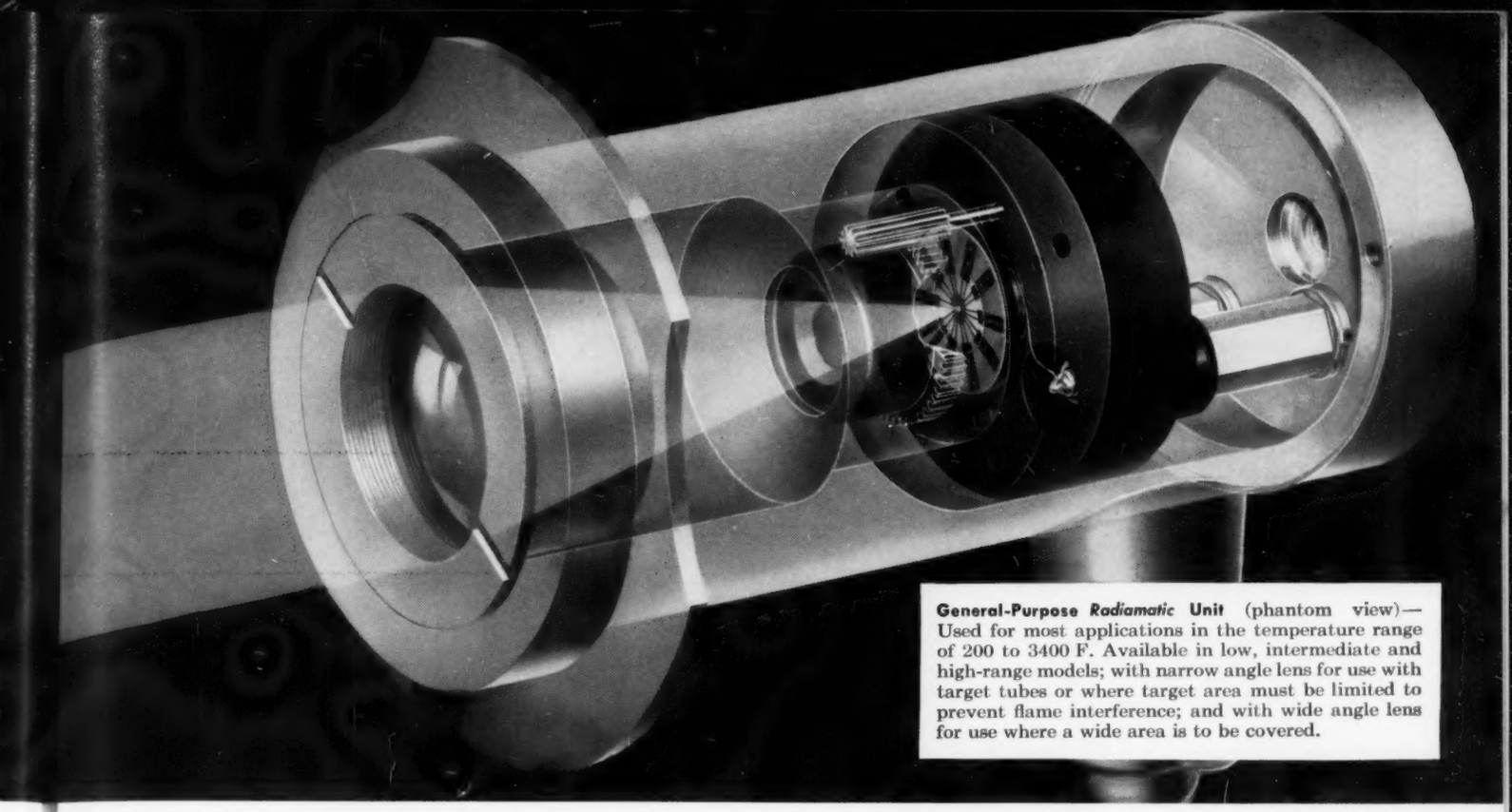
*ORIGINATORS AND LEADING PRODUCERS OF HIGH CONVECTION ANNEALING FURNACES

High-Speed *Radiamatic* Unit—For targets moving at speeds beyond the scope of general purpose, small target and miniature units. For applications where fast-moving bars or billets are targets for less than one second, and for high speed heating equipment where fuel must be shut off at the precise moment proper temperature has been reached. Average response is 98% change in temperature in less than 0.5 seconds. Two models cover the range from 1300 to 3400 F.

Have a temperature problem?

Small-Target *Radiamatic* Unit—Designed specifically for use where: the target is small; the temperature is high and heat losses through a large sighting hole cannot be tolerated; or where the sighting tube would have to be made from a costly material and must be kept small. Available in 5 models, depending on target size and temperature requirement. Temperature ranges: from 1700 to 7000 F.

Miniature *Radiamatic* Unit—Designed for the measurement of temperatures where available installation space is limited. For example, for roof measurements in open hearth installations, or mounting in small, water-cooled housings in the front wall. For temperatures from 200 to 3200 F.



General-Purpose *Radiamatic* Unit (phantom view)—Used for most applications in the temperature range of 200 to 3400 F. Available in low, intermediate and high-range models; with narrow angle lens for use with target tubes or where target area must be limited to prevent flame interference; and with wide angle lens for use where a wide area is to be covered.

• for every job, there's a Brown *Radiamatic* Pyrometer

Here are some of the benefits you can gain by choosing a Brown *Radiamatic* Pyrometer for your temperature measuring job.

- *Solves high-temperature measuring problems*
- *Provides high-speed measuring response*
- *Temperatures can be taken over a wide area*
- *Measures temperature of moving objects*
- *No thermocouple contamination or maintenance*

Radiamatic calibration is standardized. Like units can be interchanged at will without recalibrating the measuring instrument. Even above 300 F, differing ambient temperatures will not affect accuracy.

A complete line of accessories and auxiliary equipment is available to meet varied installation requirements. Included are sighting and target tubes, lenses, shutters, mounts and supports, and air and water cooled fittings.

● **REFERENCE DATA:** *Radiamatic* Pyrometers—Catalog C93-1
ElectroniK Controllers—Catalog C15-2

This flexibility enables you to use *Radiamatic* Pyrometers on open hearths, soaking pits, reheating and heat-treating furnaces, induction heating and forging furnaces, high-speed salt baths, steel temperatures during rolling and many other temperature measuring applications.

A complete line of *ElectroniK* indicators, recorders and controllers for use with *Radiamatic* units assures a control system tailored exactly to your process requirements. Recorders are available in circular or strip chart form—with a choice of electric or pneumatic controls.

Turn your temperature measuring problems over to the Honeywell man—he's as near as your phone.

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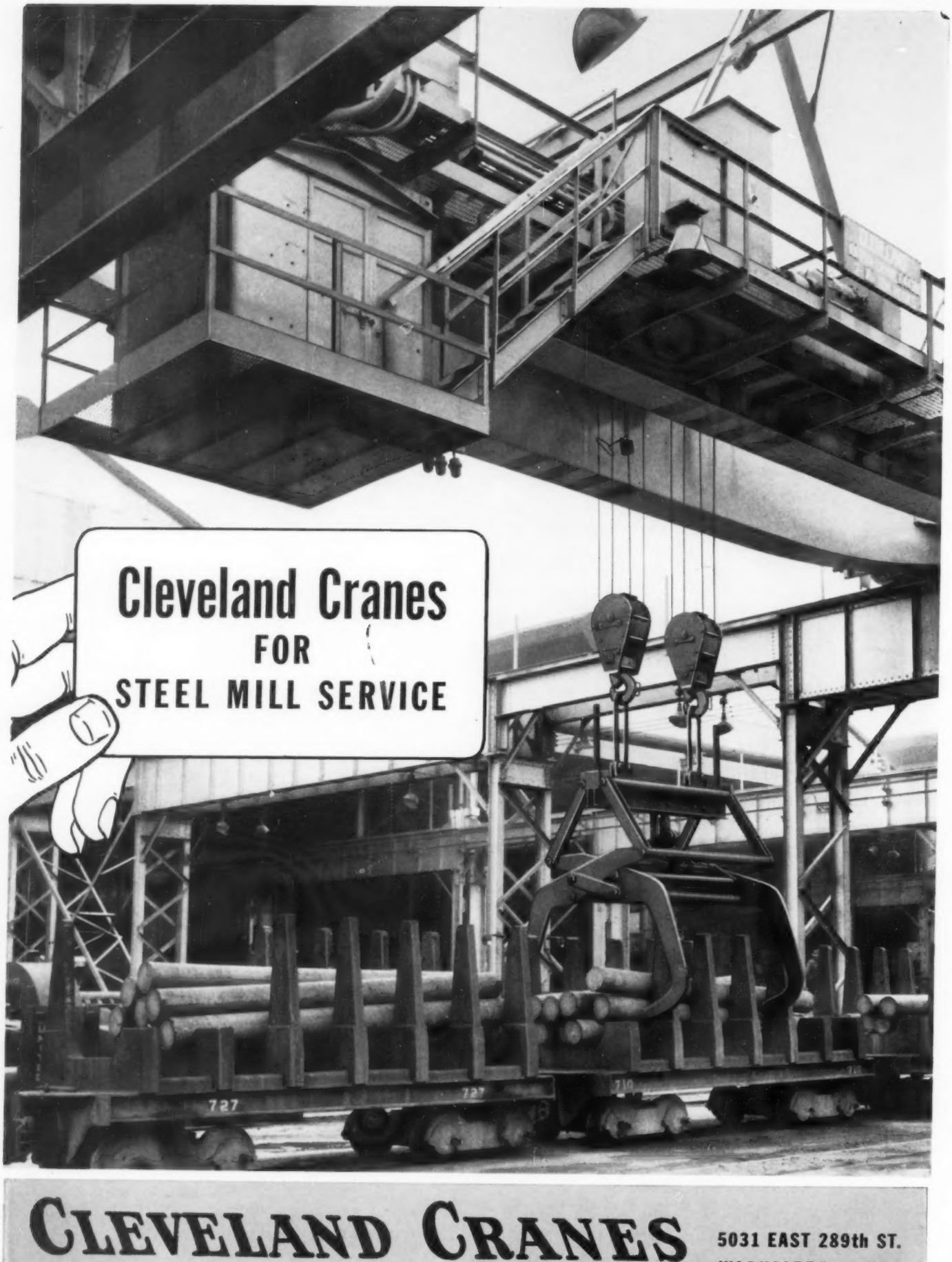
First in Control



CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

5031 EAST 289th ST.
WICKLIFFE, OHIO

Crops and Shorts

△ On page 47 of this issue, the Iron and Steel Engineer offers a new monthly feature, "Foreign Digest." This consists of condensations and listings of selected articles from foreign magazines, translated by Henry Brutcher, who has conducted an excellent, extensive translation service for many years.

Your editors believe the new department will be useful and hope it will meet with sufficient reader interest to warrant its continuance. Comments are invited.

△ An item in Typographic says: "Twenty years ago, lots of people dreamed about earning the salary they can't get along on today."

Yes, and if you go back just a little further, lots of people dreamed about earning what they now pay in income tax.

△ David J. McDonald, president of the United Steel Workers, is groaning because man-hours per ton of steel are dropping, yet he will doubtless be emphasizing the great gains in productivity six months from now. Mr. McDonald should remember that the husky wage increases he fought for and obtained make it easier to justify more and more labor-saving equipment—and make it imperative that it be used.

Mr. McDonald might better be concerned about steel imports, which hit a record high in 1958 despite depressed operations in the United States. Wire, plate, pig iron, cold rolled strip and stainless, coming variously from Japan, Germany, Spain, Britain and the Low Countries, are priced considerably lower than our domestic products. Further wage increases at home will widen the gap—and every 1,000,000 tons of steel we import, or do not export, means 20,000 less steelworkers, or $120,000,000 less payroll.

△ Somewhat along the same line, B. F. Fairless, president of the American Iron and Steel Institute, told the American Steel Warehouse Association that extravagant wage increases will "boost national wage rates to what the most efficient industry can pay. The less efficient industries, through no fault of theirs, will be strangled by costs."

△ Some of the biggest Christmas surprises came when husbands saw the presents they gave their wives.

△ C. M. White, chairman of Republic Steel Corp., said in his year-end statement: "Viewed against a background of a reversal of the inventory liquidation trend which hit steel so hard last year, plus expected improvement in the role of consumer durables in line with rising income payments, and purchase of new types of manufacturing equipment that raise efficiency, the steel industry has a bright outlook as it enters the new year."

△ In spite of all the beautifully equipped kitchens in modern homes, Americans spend more than $50,000,000 a year on grills, barbecue units, etc. We'll bet those rugged pioneers like to rough it without an electric blanket, too.

△ Speaking at the annual dinner of the Newcomer Society, Roger M. Blough, chairman of United States Steel Corp., pointed out that our nation's proportion of world steel production has dropped from 54 per cent in 1946 to less than 30 per cent in 1958.

△ We've heard a rumor that a point in future labor-management negotiations will be another day off with pay to make up for coffee breaks missed during vacations.

△ The estimated 1958 payroll for the steel industry declined only about 13 per cent under 1957, although steel production dropped 25 per cent.

△ Two new continuous strip mills will be built in Britain, one at Richard Thomas & Baldwins, Ltd., at Newport, South Wales, one at Colvilles, Ltd., Lanarkshire, Scotland. Each will have a nominal capacity of 500,000 tons per year. In both cases the locations were selected by Parliament.

△ An item in Powerfax tells of a bachelor who buys a number of 25-cent insurance policies whenever he makes a plane flight. He claims sending a policy to each of his girl friends, naming her as sole beneficiary, really pays off.

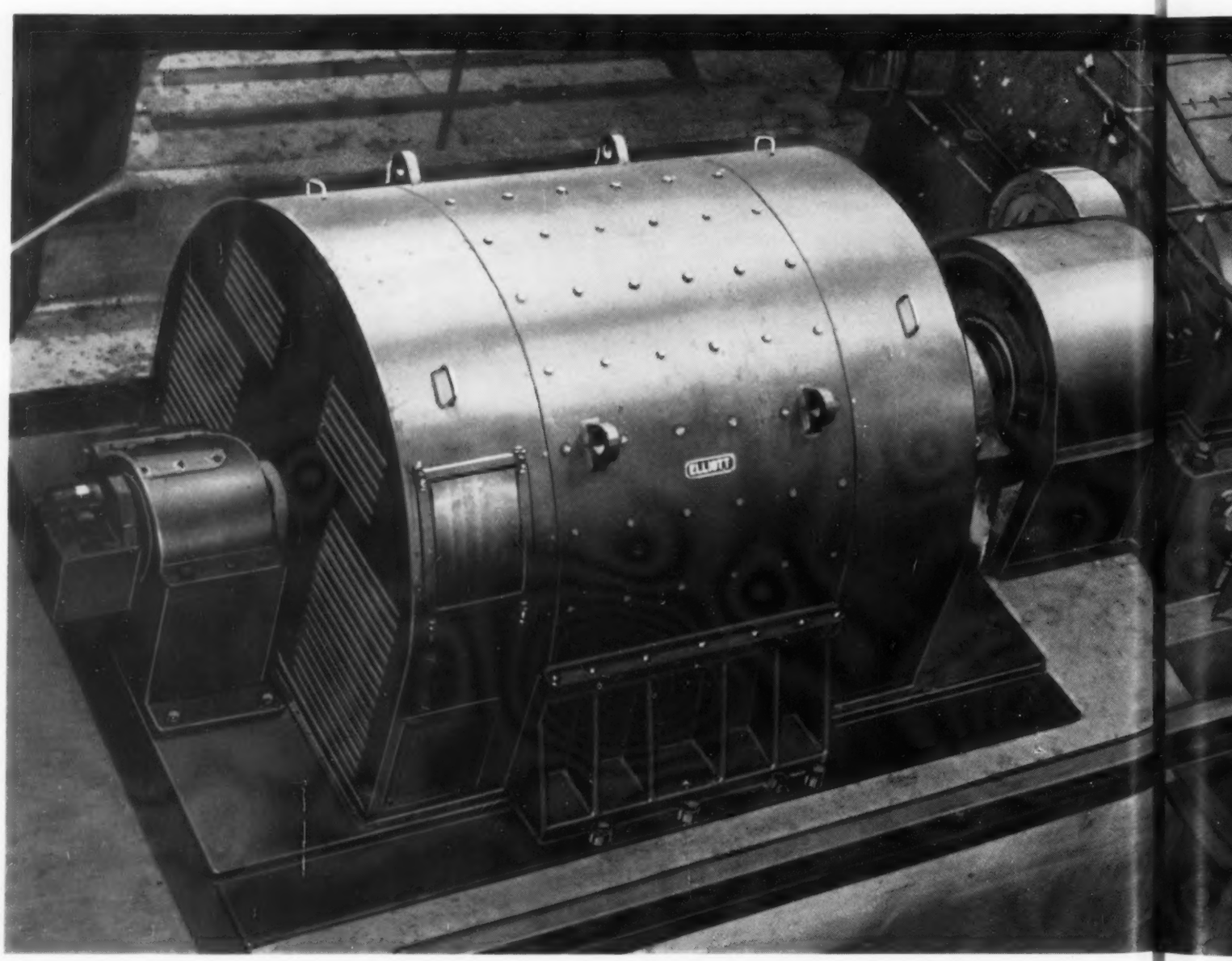
△ Comes again the time for looking into the crystal ball. Various seers have come up with this outlook for 1959: Ingot production between 105,000,000 and 112,500,000 tons. A spotty pickup in machinery and industrial equipment. Automobiles between 5,500,000 and 6,000,000. A new record in construction outlays at about $52,000,000,000. A good (but not record-breaking) year for electrical manufacturing. Somewhat steeper wage increases in spite of stiffer resistance. Higher prices. Finally, we're afraid, a real humdinger of a steel strike.

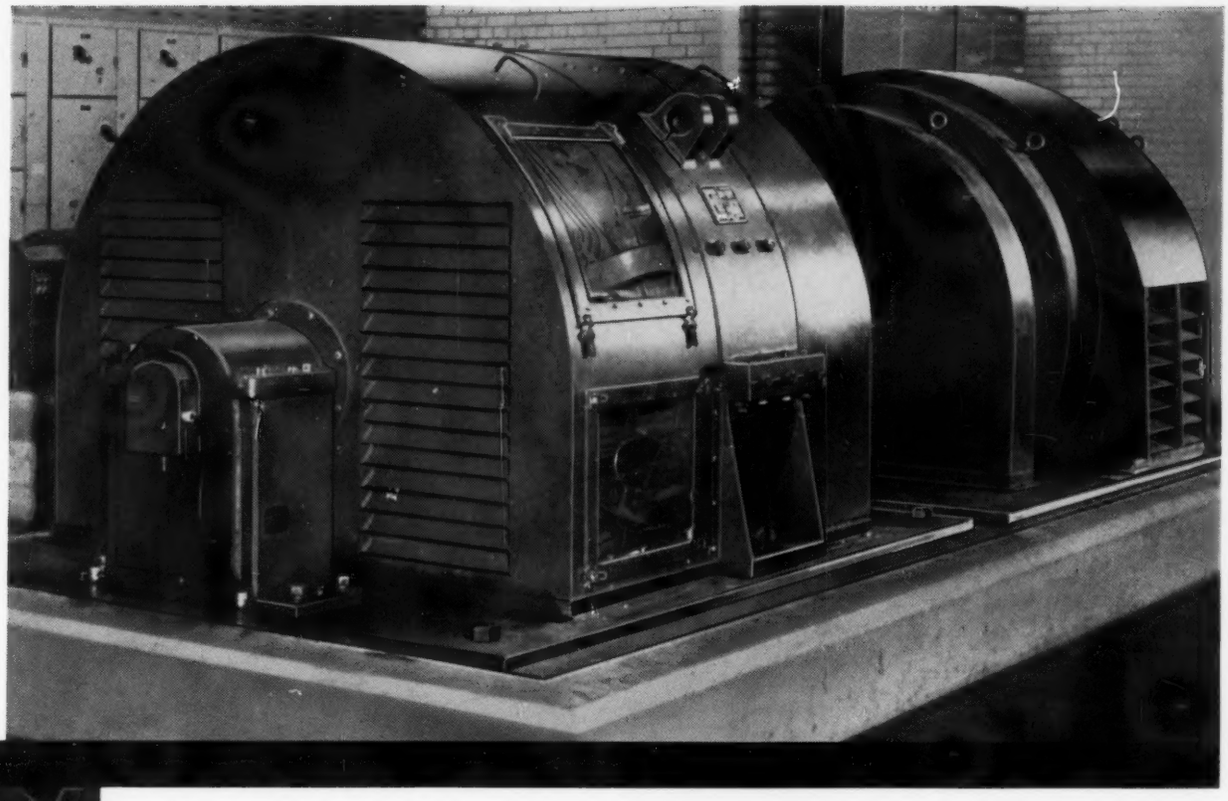
△ Tennessee Ernie Ford says the mind is a wonderful thing. It starts working the minute you're born and never stops until you stand up to speak in public.

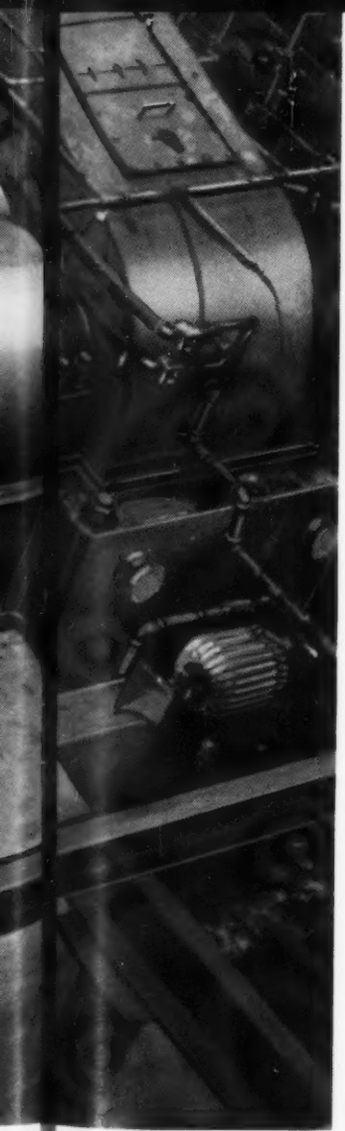
△ According to the American Iron and Steel Institute, new annual capacities in the industry stand at 73,098,310 net tons of coke, 94,634,850 net tons of iron, and 147,633,670 net tons of steel. The last item includes 126,500,000 tons of open hearth capacity, about 13,500,000 tons of electric furnace capacity, 4,033,160 tons of oxygen converter capacity, and 3,600,000 tons of bessemer capacity.

ELLIOTT EQUIPMENT powers nation's first mill FOR MECHANICALLY EXPANDING SEAMLESS TUBING

The main mill motor, seen below, is an Elliott force-ventilated 1500-hp, 80/200-rpm, 600-volt d-c motor, with low inertia and special high-torque capacity of 275 percent full load. Power for the tube-expanding motor is furnished by the Elliott motor-generator set, at the right. This two-unit force-ventilated m-g set, with peak load capacity of 275 percent, consists of a 600-volt d-c generator, driven by a 1750-hp, 13,800-volt synchronous motor. Elliott Company also furnished all the control and switchgear required.







designed and engineered to meet rigorous production requirements

Mechanical expanding of seamless steel pipe is accomplished by forcing a water-lubricated ram and plug through the pipe with the application of 300,000 lb of pressure. The ram is driven by two heavy chains attached to a crosshead. The cold working of the metal during the expanding adds to its strength and weldability.

Elliott machines are engineered and built to keep pace with accelerated production and to meet the most severe application requirements. FABRI-STEEL construction and FABRI-SEAL winding insulation assure long, trouble-free operating life. Easy access is provided for routine inspection and maintenance. In each installation, the application of Elliott equipment is coordinated by the Elliott Company.

Bulletin Q-23A gives photographic illustrations of Elliott's range of experience as a supplier to steel and related industries. *Write Elliott Company, Ridgway Plant, Ridgway, Pa., for your copy.*

ELLIOTT Company

R9-1

Youngstown Sheet and Tube normalizing furnace lined with B&W Insulating Firebrick

Designed and constructed by Salem Brosius, Inc. for the Campbell Works of Youngstown Sheet and Tube Company, Youngstown, Ohio, the 57′ x 38′ inside chamber of this huge new walking beam furnace is completely lined with lightweight B&W Insulating Firebrick.

This giant furnace is used to normalize seamless oil well casings and operates continuously at a temperature of 1700 F.

The B&W IFB used in the walls and suspended roof of this furnace are the lightest insulating firebrick made. This light weight and consequent low heat storage keep furnace walls at uniform temperature to provide the most efficient heating conditions. B&W IFB also reach uniform temperature faster with less fuel consumption, which means appreciable savings to furnace operators.

In addition, lightweight B&W IFB make possible more economical suspended roof constructions. They also simplify brick installation and replacement.

For information on how B&W Insulating Firebrick can lower your furnace operating costs, consult your B&W Refractories Representative or write for Bulletin R-2-H.

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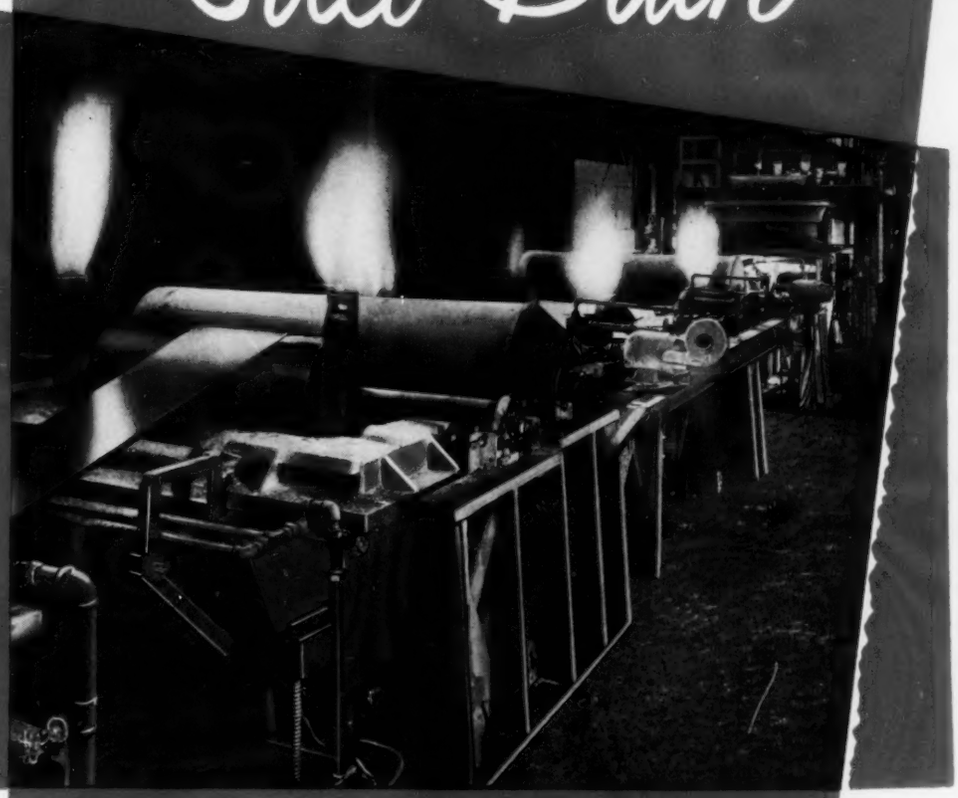
R-999

DREVER Salt Bath

for CONTINUOUSLY DESCALING STAINLESS STRIP



Equipment shown descales 18,700 lbs/hour cold reduced stainless strip 52" wide x .018" to .096" gauge. Maximum operating temperature of bath—960°F

The above 35'-0" long Drever Continuous Descaling Bath will descale 18,700 lbs/hour when strip enters bath at bath temperature. Entering strip temperature is controlled by regulation of quenching temperature after strip is discharged from a catenary annealing furnace.

Drever descaling baths are heated by gas-fired immersion tubes with proportioning automatic temperature control.

Other baths are supplied for continuous or batch operation for strip, plate, wire, tubing and other ferrous or non-ferrous products.

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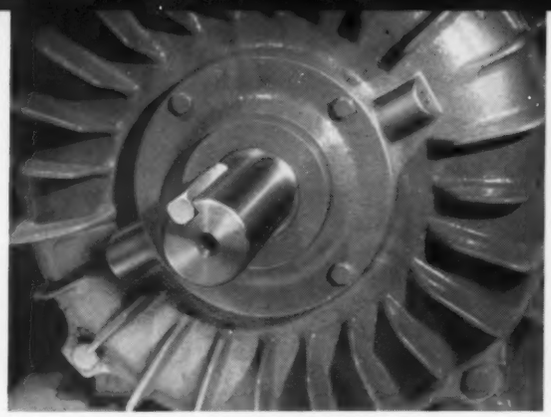

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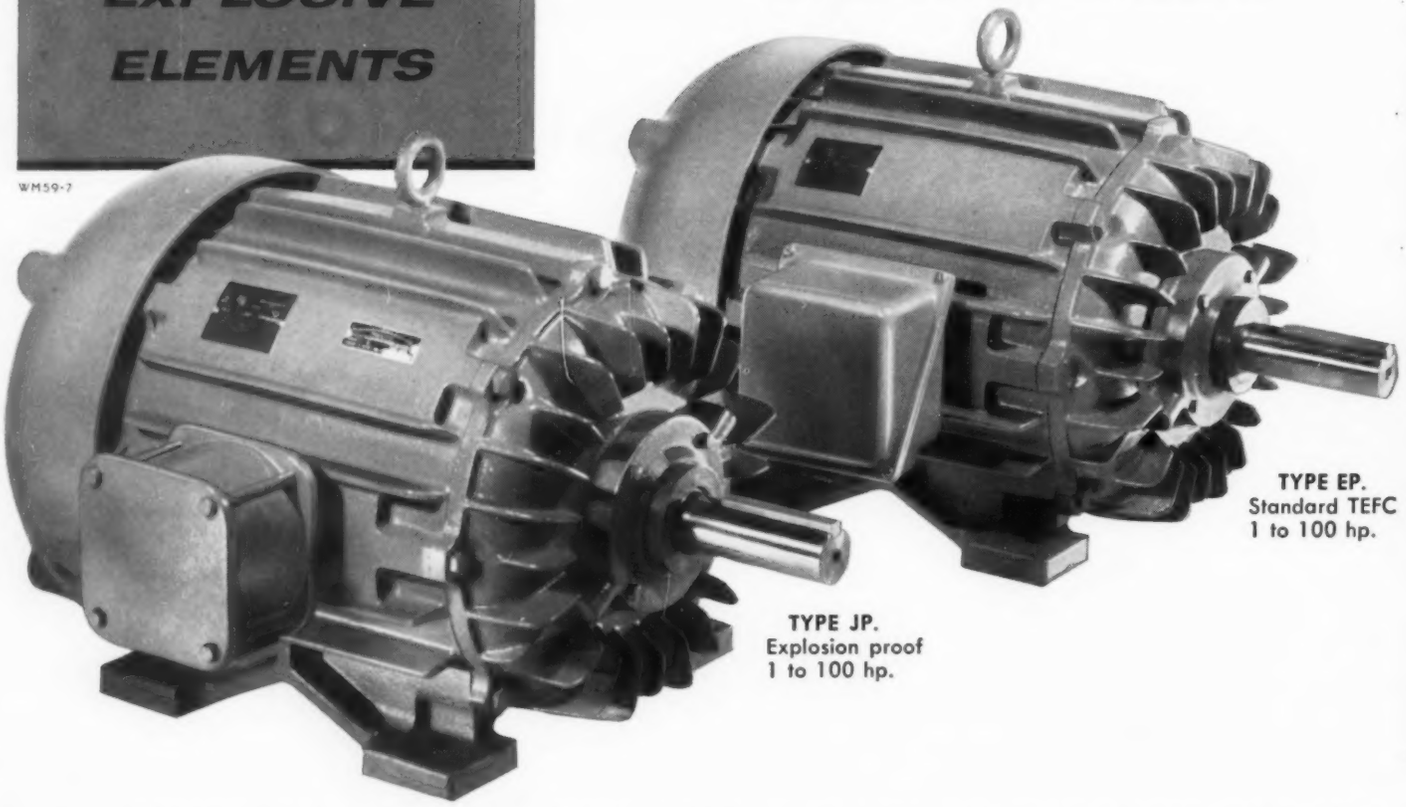

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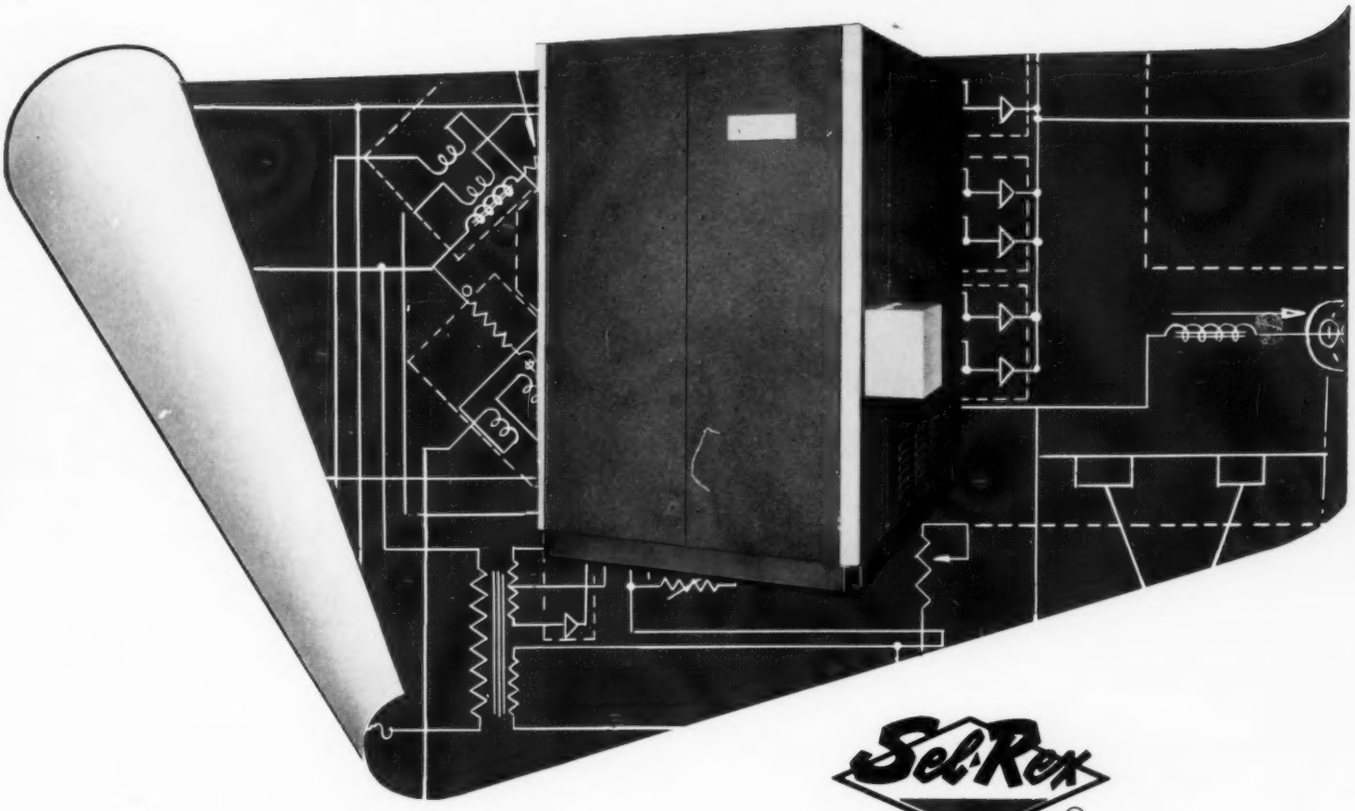

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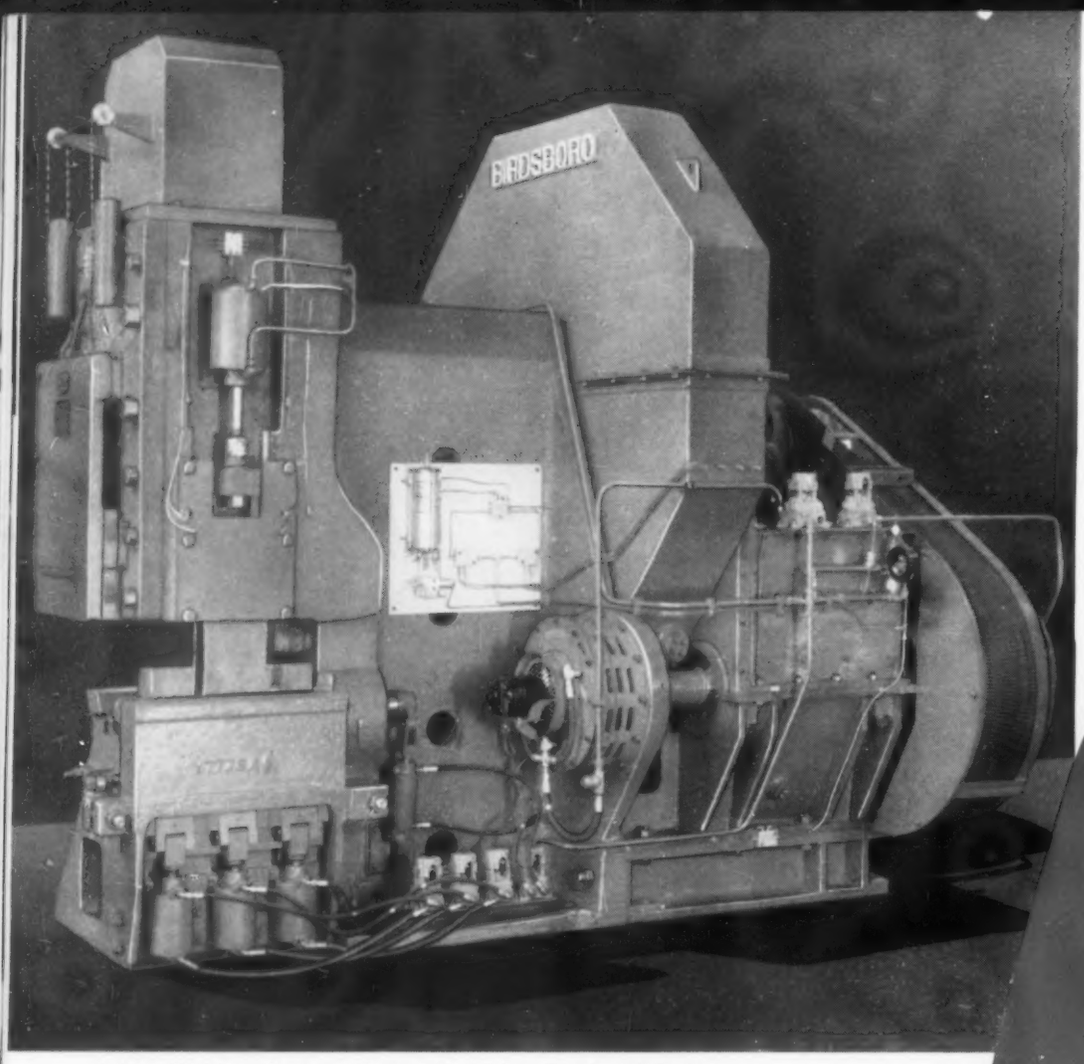

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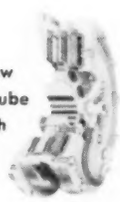

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patent reviews

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents . . . . patents reviewed cover period August 5, 1958 through August 26, 1958

COMBINATION PICKLING AND COATING BATH

△ U. S. 2,846,341, issued Aug. 5, 1958 to William C. Johns and Wesley J. Wojtowicz, assigned to the H. A. Montgomery Co., describes a method of pickling ferrous metal surfaces to remove rust and scale and to form in situ on the pickled surfaces a chemically bonded coating serving both as a drawing aid and as a protective coating, all in the course of a single immersing operation.

The ferrous metal articles are immersed in a heated aqueous solution containing 2 to 15 per cent of a strong pickling acid such as sulphuric or hydrochloric, and at least 2 per cent of oxalic acid. To achieve more rapid coating, a more chemically inert coating, and greater coating thicknesses, the solution should also include 0.3 to 5 per cent of an oxidizing agent that is soluble in the solution, such as ferric oxalate, ferric chloride or ferric sulphate.

GASEOUS REDUCTION OF IRON ORE

△ U. S. 2,848,316, issued Aug. 19, 1958 to William L. Davis, Jr., Jerome Feinman, and Leslie R. Little, Jr., assigned to United States Steel Corp., describes a method of reducing iron ore in fluidized beds in which the maximum particle size is increased to about $\frac{1}{4}$ or $\frac{3}{8}$ in. and particle sticking is avoided.

The presence of a few particles larger than 10 mesh affords the advantage of permitting higher gas velocities without increased dust loss.

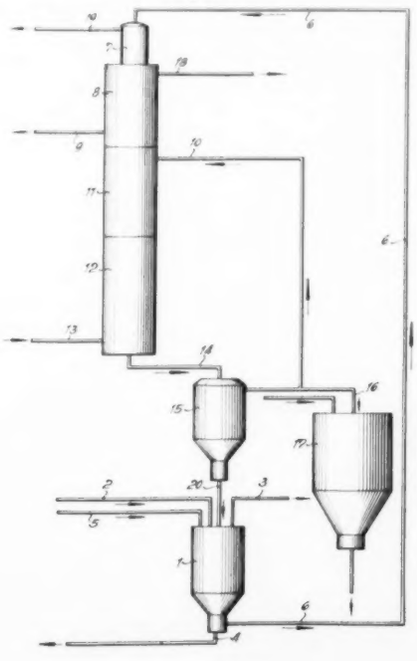
DESULPHURIZING OF STEEL

△ U. S. 2,848,317 issued Aug. 19, 1958 to Werner Coupette and Adolf Sickbert, assigned to Bochumer Verein fur Gusstahlfabrikation A.G., describes a method by which steel may be extensively desulphurized in a single rapid process.

Molten steel is poured into a vacuum chamber under such conditions that the stream of molten steel as it enters becomes subdivided into fine droplets. These fine droplets then come in contact with and react with the desulphurizing agents in the vacuum chamber.

The disintegration of the molten steel stream into small droplets is of particular advantage in causing a rapid and effective desulphurization, especially in combination with the reduced pressure, which furthers the ability of the steel to evolve gas during the desulphurizing reactions.

Figure 1



PRODUCTION OF AMMONIUM SULPHATE AND FERROUS HYDROXIDE FROM WASTE PICKLE LIQUOR

△ U. S. 2,848,302, issued Aug. 19, 1958 to Alfred Jappelt, Alexander Doerges and Helmut Schade, assigned to F. J. Collin A.G., describes a method of recovering chemicals from waste pickle liquor and at the same time purifying coke oven gas.

As shown in Figure 1, waste pickle liquor is introduced into a decomposer 1 by line 2, along with sulphuric acid and water by pipe 5, and recirculated sludge by pipe 20. The reaction yields gaseous hydrogen sulphide which is evolved through pipe 3, insoluble ferrocyano-compounds which are withdrawn at 4 and a neutral or weakly acid strong solution of ferrous sulphate which is fed to the next stage of the process by pipe 6. The hy-

drogen sulphide which is released can be further processed in the known manner to sulphuric acid or sulphur. The iron cyanide compounds removed at 4 are worked into Prussian blue.

The ferrous sulphate solution is degasified in degasifier 7 by means of a small part of already purified coke-oven gas. The gas takes up hydrogen sulphide from the solution. It is fed back by pipe 19 to the crude gas on the suction side of the exhauster, not shown. The degasified solution is contacted in the second stage 8 of the process with coke oven gas containing ammonia and coming from the third stage of the process. Thereby ammonia is removed from the gas, and part of the purified gas passes out by pipe 18. In the liquor, ammonium sulphate is formed, and some ferrous hydroxide is precipitated. This hydroxide or part of it may be withdrawn by pipe 9 by separating the precipitate and returning the filtrate to the scrubber 8. In the next or third stage 11 of the process, the liquor from the second stage 8 of the process is contacted with coke oven gas containing ammonia, coming from the fourth stage 12 of the process. Also, a circulating ammoniacal solution of ammonium sulphate is added through pipe 10. As a result, most of the ferrous sulphate still contained in the liquor from contacting stage 8 is reacted to form ferrous hydroxide and ammonium sulphate. In the fourth stage 12 of the process, the liquor from stage 11 is contacted with crude coke oven gas containing ammonia, hydrogen sulphide and hydrogen cyanide and entering through pipe 13. Ferrous hydroxide is reacted with hydrogen sulphide and hydrogen cyanide, forming insoluble ferrous sulphide and ferro-cyano compounds. The sludgy liquor is fed to the fifth stage of the process; namely, a sludge separator or filter 15 through pipe 14. The resultant precipitated ferrous sulphide, ferro-cyano-compounds and some ferrous hydroxide, are fed to the decomposer 1 through pipe 20. By reaction with pickle liquor and sulphuric acid, hydrogen sulphide is evolved and ferrous sulphate in solution is formed. There remains a residue of insoluble ferro-cyano compounds.

The liquor from the sludge separator 15 is a slightly ammoniacal or strong solution of ammonium sulphate. Part of it is recirculated to the contacting stage 11. Another part is fed to evaporator plant 17 by pipe 16 and processed to crystalline ammonium sulphate by evaporation.

SMELTING FINELY DIVIDED IRON ORE

△ U. S. 2,846,302, issued Aug. 5, 1958 to William E. Greenawalt, describes a process for smelting milling ore too low in grade to be advantageously smelted direct.

As shown in Figure 2, finely ground ore, usually wet or moist, is delivered into the receiving bin 1, from which it is fed in a regulated stream into the drier 2, and delivered into the receiving bin 3; and from there fed, by means of the feeder 4, into the melting furnace 5, in which it descends in showered form through the highly heated atmosphere of the melting furnace to melt it. The mixture of molten iron ore and hot melting furnace gas flows in a continuous stream into an enclosed chamber 6 where the melting furnace gas is separated from the molten ore. The molten ore, separated from the melting furnace gas, flows through the duct 7 into a rotary mechanism 8, operating at high speed, which ejects the molten ore as a spray into the highly heated reducing atmosphere in the upper part 10 of a

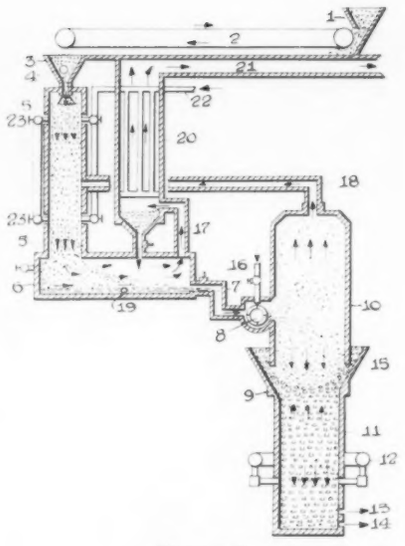


Figure 2

vertical shaft smelting furnace 9. The smelting furnace is divided vertically into an upper section 10 containing highly heated reducing gas, and a lower section 11 filled with coal or coke in permeable lump form, and heated with air delivered into it by means of the tuyeres 12. The carbon is fed into the lower part of the smelting furnace 11 through the feeders 15. The reduced molten ore accumulates in the smelting furnace hearth into layers of pig iron and slag. The slag is removed through the slag hole 13, and the pig iron through the tap hole 14.

The column, or mass of carbon in the smelting furnace is heated to about the same temperature and in

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or assignee
2,846,041	8/5/58	Retractable coil stop	United States Steel Corp.
2,846,344-5	8/5/58	Carburization of steel	Imperial Chemical Industries Ltd.
2,846,741	8/12/58	Hot top	The Whitacre-Greer Fire Proofing Co.
2,846,754	8/12/58	Scrap metal breaker	Alexander Raizk et al.
2,846,931	8/12/58	Grating structure	United States Steel Corp.
2,847,114	8/12/58	Belt conveyor	United States Steel Corp.
2,847,120	8/12/58	Package for tin plate	United States Steel Corp.
2,847,133	8/12/58	Blast furnace charging regulator	Charles A. Janner
2,847,203	8/12/58	Heat treating apparatus	Vernon H. Ferguson
2,847,301	8/12/58	Production of stainless steel	Allegheny Ludlum Steel Corp.
2,847,337	8/12/58	Production of cast iron having needle-shaped crystalline structure	Alfred Teves, Maschinen- und Armaturenfabrik KG
2,848,207	8/19/58	Furnace for the scale-free heating of metals	Metallurgical Processes Co.
2,848,214	8/19/58	Continuous sintering machine	Koppers Co., Inc.
2,848,323	8/19/58	Ferritic steel for high temperature use	The Birmingham Small Arms Co. Ltd.
2,848,975	8/26/58	Apparatus for continuous coating of metal strip	Sharon Steel Corp.
2,849,128	8/26/58	Control system for coke-oven pusher	United States Steel Corp.
2,849,288	8/26/58	Recovery of ammonia and pyridine from coke oven gases	Monsanto Chemical Co.

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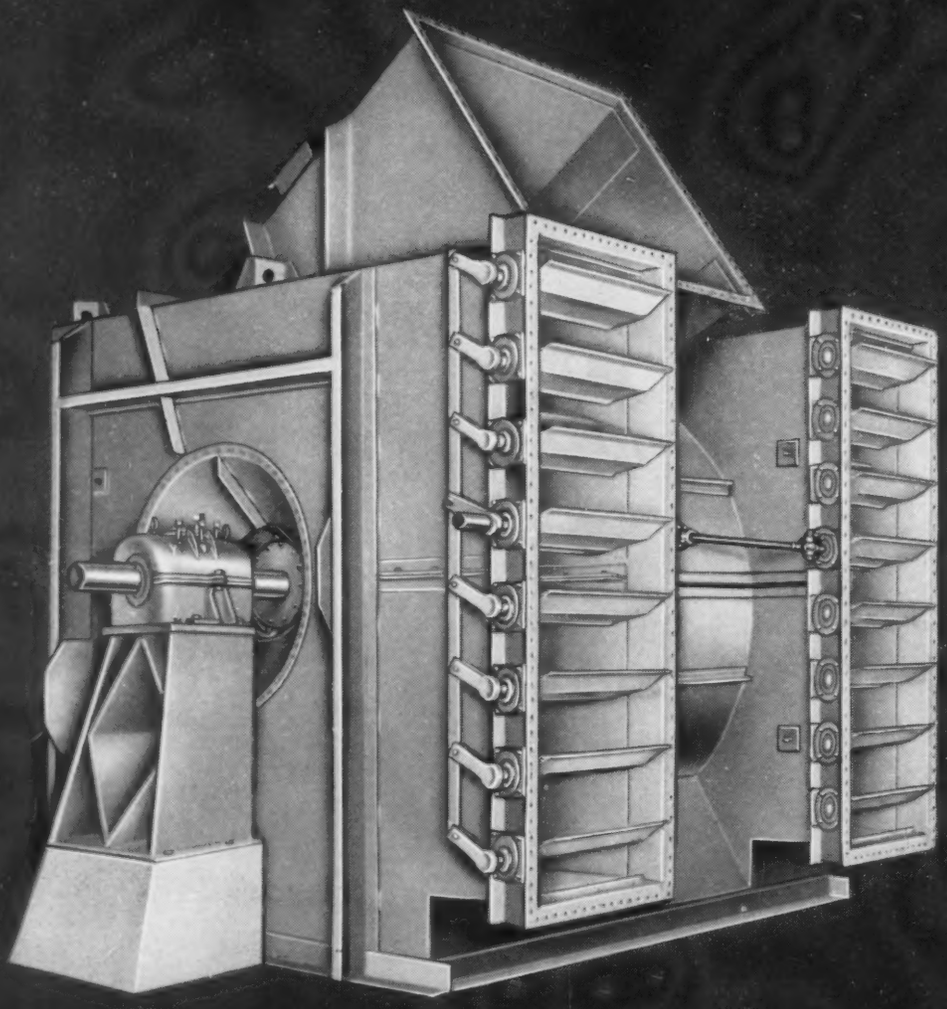

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much the same way as in regular iron blast furnace smelting, or 2600 to 3000 F at the bosh and tuyere zone. The gas issuing from it is delivered into the spray, or upper section of the smelting furnace at a correspondingly high temperature and rich in carbon monoxide. But this hot gas will not usually be large enough in volume or concentrated enough for effective reducing operations in the spraying section of the smelting furnace. A fluid reducing agent, such as powdered coal, petroleum, or natural gas, may be injected into it to meet the reduction requirements.

It is preferred to introduce all or part of the fluid reducing agent into the rotary mechanism 8, through pipe 16. This gives a thorough mixture of molten ore and reducing agent in the rotor.

The hot gas, rich in carbon monoxide, issuing from the top of the smelting furnace 9 flows through the duct 18 into the melting furnace oxidizing atmosphere, where the carbon monoxide is burned to furnish part of the heat necessary to melt the ore. Hot air, or additional fuel or reducing agent may be introduced into the melting furnace through the burners 23. The melting furnace will usually be operated with an oxidizing atmosphere at the top to facilitate the heating, and with a reducing agent at the bottom to facilitate the reduction. If so operated the resulting molten ore will consist of a mixture of reduced and unreduced iron oxide, and their relative proportions may be regulated as desired.

The hot melting furnace gas issuing from the gas separating chamber 6 flows through the duct 17 into a heat exchanger 20, where most of the dust is settled out, and fresh air is heated, through the pipes 22, which may be used anywhere in the general process.

U. S. 2,846,301 (same date and inventor), describes a modified version of the process.

PROCESS FOR SMELTING ORES

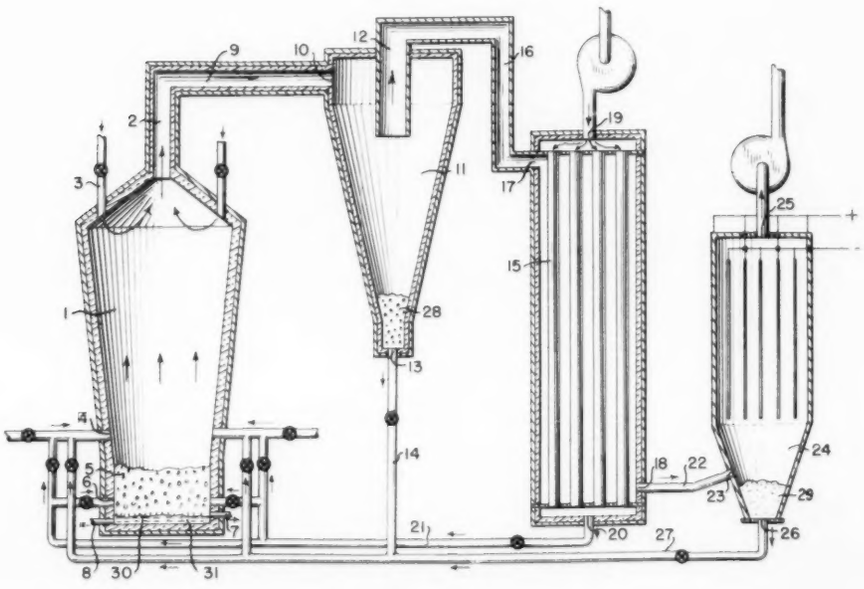
△ U. S. 2,846,300 issued Aug. 5, 1958 to Werner Wenzel, describes a process for smelting finely divided iron ore with gaseous, liquid or powdered solid fuels.

As shown in Figure 3, a reaction mixture is injected through inlet nozzles 4 into the reaction or melting chamber 1. This mixture consists of prereduced ore 28, which is conveyed from the prereduction chamber 11 by the conveyor 14, of fine dust 29 from the electric cleaning installation 24 which is fed to the prereduced ore 28 and mixed with it, of the fuel (fine coal), and the combustion medium which, consisting for example of air enriched with oxygen, has been preheated in the heat exchanger 15 to a temperature of 800 C. In the melting chamber, the fine coal, ore dust and combustion medium react together in the space in front of the injection nozzle 4. Liquid iron and liquid slag form and sink chiefly in the form of drops onto the coke bed 5. In the coke bed 5 the slag is completely reduced, and the iron deoxidized and carburized. With the aid of the lime fed into the melting chamber through the apertures 3, the iron is desulphurized and enriched with certain alloy components such as manganese or silicon. The slag collects below the coke bed 5 in a coherent layer 30, and the iron in a layer 31. The molten slag and iron are drawn off through tap holes 7 and 8.

The combustion gases forming in the reaction chamber in front of the injection nozzles 4 pass upwards in the reaction chamber and out through the gas outlet pipe 2. Coke and lime (CaO) or other mixtures are fed into the reaction chamber 1 through the inlet apertures 3 in lump form and fall counter-current to the upwardly directed gas current onto the coke bed 5. Cold ore dust is also introduced through the inlet apertures 3 and, owing to its low velocity of descent, it is carried along and at the same time heated by the ascending gas current and passes on to the prereduction chamber 11 through the gas outlet 2 and line 9. Owing to the heating of the ore dust, the temperature of the combustion gas drops quickly from about 1600 to about 1000 C.

The cooling of the waste gases from the reaction chamber may be effected by additional measures, such as, for example, by water-cooled pipes, in order to bring the temperature of the solid components below the melting or sintering point, so that these components pass with the waste gases into the prereduction chamber 11 at a temperature of about 1000 C. In the prereduction chamber 11, which is shown as a cyclone, the mixture composed of the waste gases from the reaction chamber and the ore dust is blown tangentially through the inlet 10. Due to the cyclone effect, the reduced ore 28 is separated, and it is brought into the reduction space of the reaction chamber 1 through the outlet 13 and over the conveyor 14. The waste gases, freed to an extent from the ore dust in the cyclone 11, leave through the central outlet 12 and are fed at a temperature of about 1000 C through line 16 to the gas inlet 17 of the heat

Figure 3



exchanger 15. The heat exchanger is of the known type with a system of tubes and with the gas to be cooled flowing around the tubes and leaving through gas outlet 18. The cold combustion medium is fed into the heat exchanger 15 through the inlet 19. It leaves the heat exchanger at a temperature of about 800 C through the outlet 20 and is fed through line 21 to the injector nozzles 4 of the reaction chamber 1. The cooled gas after leaving the heat exchanger 15 through gas outlet 18 is conducted by the conduit 22 to the electric gas cleaning installation 24 which it enters through the inlet 23 at a temperature of about 250 C. The dust 29 is separated in the electric gas cleaning installation. The cleansed gas leaves through the outlet 25 and is available for heating purposes. At the lower end of the installation 24 the separated dust is drawn off at 26 and fed to the reaction chamber 1 by the conveying means 27.

SOAKING PIT FURNACE

△ U. S. 2,849,221, issued Aug. 26, 1958 to Carroll Cone and Donald K. Martin, assigned to Surface Combustion Corp., relates to recirculation of flue products in a one-way fired soaking pit furnace, to prevent stagnation and maintain uniformity of pit temperatures.

As shown in Figures 4 and 5, heating burner 22, represented by dotted lines in Figure 4, fires through burner port 23. Recirculating burners 24 fire into combustion chambers 25. Combustion gases exit through nozzles 26, across ducts 27, and through venturi tubes 28. After circulating through chamber 11 in a horse-shoe shaped path, indicated by arrows 39, these gases leave through exhaust ports 29. Part of these gases is then carried through ducts 27 and back through tubes 28 by an inspiration effect produced by the high velocity combustion gases from chambers 25 passing through tubes 28. The remaining gases travel through passage 30, tile recuperator 31, metal recuperator 32, and out stack 33. High pressure air is blown by blower 34 through metal recuperator 32 and by-pass 35, if desired, duct 36, nozzle 37, and into venturi 38. Low pressure air, induced from the inspirating effect of jet pump 40,

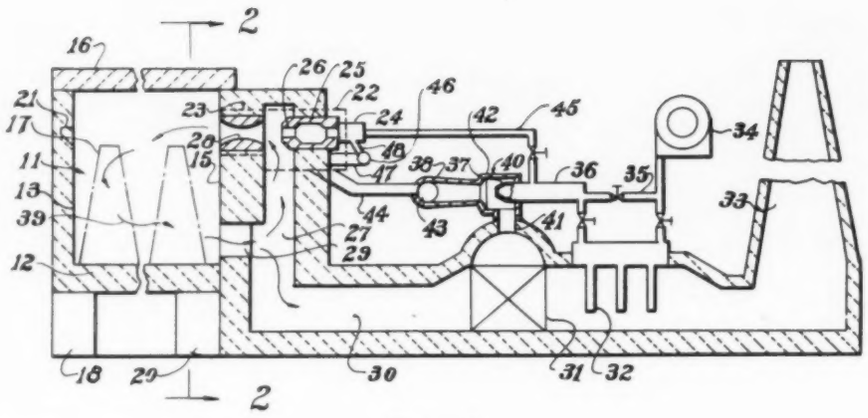


Figure 4

enters through tile recuperator 31, passage 41, housing 42, and into venturi 38. The total air then enters manifold 43 which may supply combustion air to a battery of several pits. Duct 44 leads from this manifold to the heating burner 22 on each pit. Air for the recirculating burners 24 is taken from the high pressure air in duct 36 and carried by pipes 45. Manifold 46 supplies fuel to heating burner 22 and recirculating burners 24 by pipes 47 and 48, respectively.

DEVICE FOR COMBINED REPEATING OR STRAIGHT ROLLING

△ U. S. 2,847,887, issued Aug. 19, 1958 to Edward T. Peterson, assigned to Birdsboro Steel Foundry & Machine Co., relates to combinations of rolling mill repeaters which provide for reversal of stock from one roll stand to the next, with troughs associated with and movable with the repeaters, so that change-over can be made very quickly from reversal of small gage stock by the repeaters to reversal of straight stock by the troughs operating with a transfer.

The purpose of the invention is to avoid the delay and downtime which has been incident to removal of repeaters from a rolling mill, especially a bar mill.

In Figure 6, a rolling mill comprising roll stands 20, 21, 22, 23, 24, and 25 is arranged conventionally, for example in a staggered arrangement as illustrated. The work passes on a pass line 26 to repeater 27 and there is reversed to enter at pass line 28 on roll stand 21. The work leaving on pass line 28 enters repeater 30 and is reversed and then enters roll stand 22 on

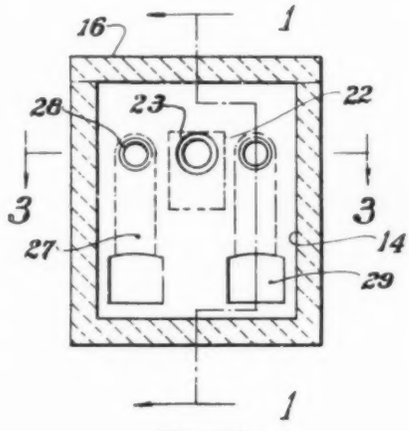


Figure 5

pass line 31 and is carried to the repeater 32 where it is reversed and enters roll stand 23 on pass line 33. Work leaving roll stand 23 is reversed by repeater 34, and enters roll stand 24 on pass line 35, and from roll stand 24 it is reversed by repeater 36 and enters roll stand 25 on pass line 37, then being carried from the mill to any suitable equipment such as a flying shear and cooling bed.

Beneath the repeaters, rails 38 extend in the direction of the rolling mill axis, and the respective repeaters ride on the ways so that they are slidable bodily to bring them into proper alinement. The repeaters shown in Figure 6 are double trough repeaters having upwardly open U-shaped troughs 40 and 41 so that they can handle two separate strands of work at the same time, as shown in Figure 7.

In accordance with the present invention each of the repeaters is provided with a cross trough 44 which is generally at right angles to the axis of the rolling mill roll but slightly inclined to cooperate better with the transfer. The cross trough 44 has side walls 45, as seen in

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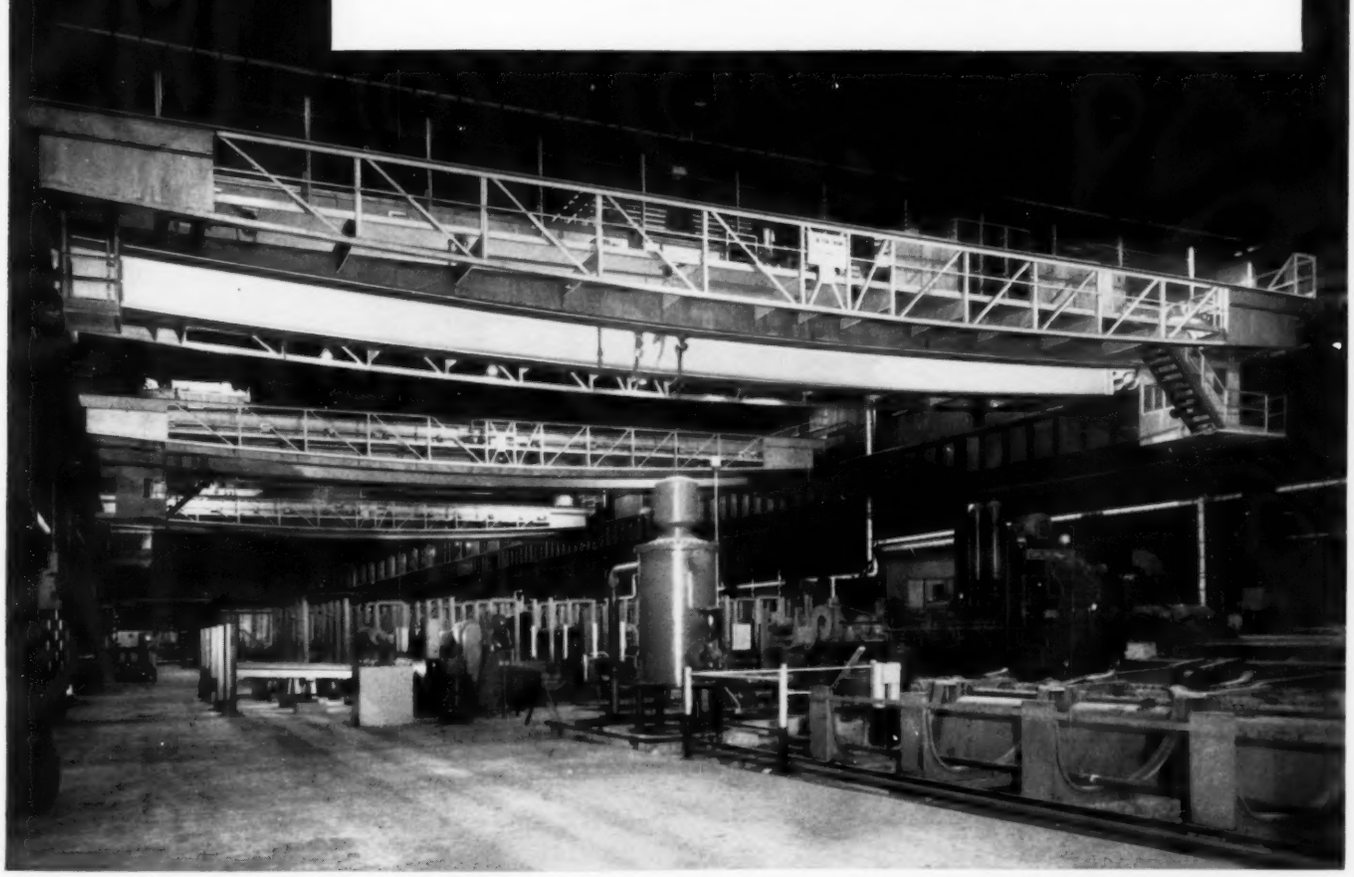

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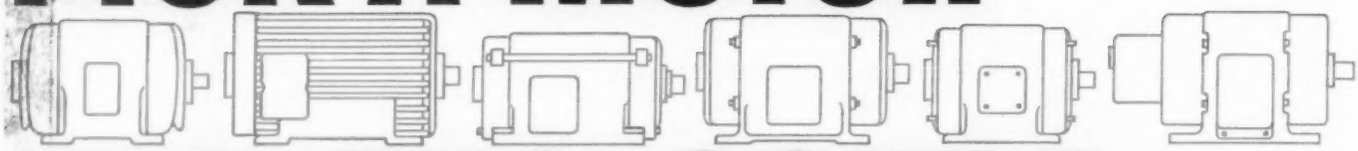

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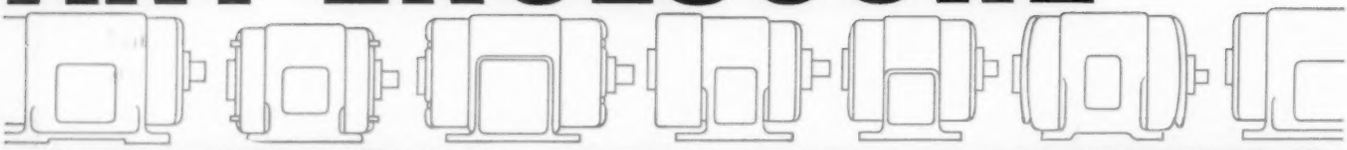

SWITCH IN MINUTES

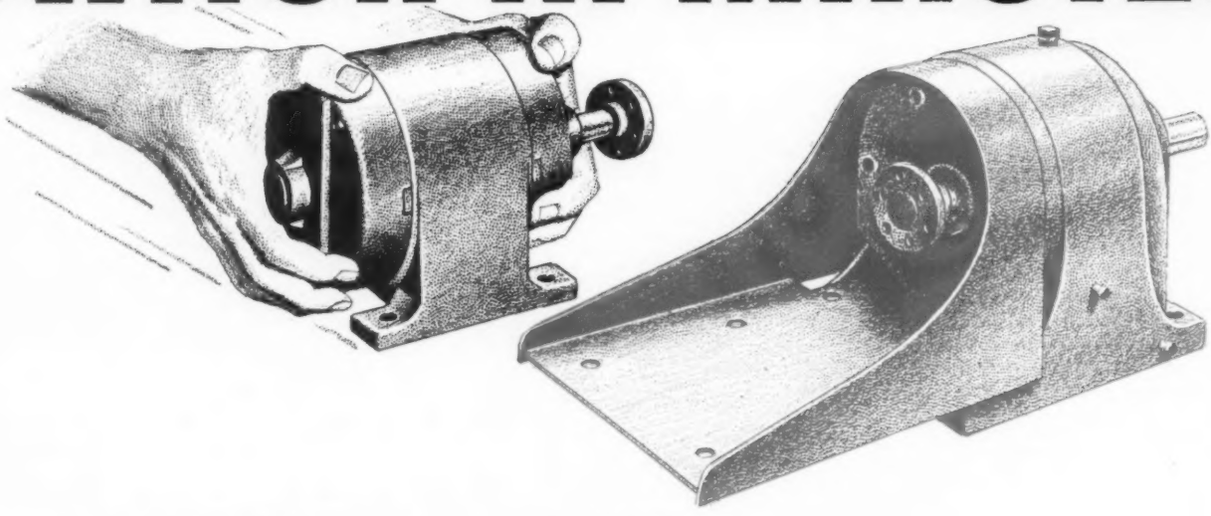

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Figure 7. Thus, when the cross troughs 44 are brought into alinement with the appropriate rolling mill stand, the work extends through the cross trough and above the repeater troughs.

If the work is to be handled as straight stock, each of the repeaters is moved bodily to bring the appropriate pass line. A table transfer of suitable type is provided at 47 behind each repeater lined up properly for operation when the repeaters are moved to bring their cross troughs into alinement.

APPARATUS FOR MAKING BOTTOM IN SOAKING PITS

△ U. S. 2,846,090, issued Aug. 5, 1958 to Thor Engstrom and Frank L. Rice, assigned to United States Steel Corp., expedites the making of soaking pit bottoms in that it eliminates troublesome pit crane operations incident to conventional bottom making practice and in that only a single trip of the pit crane is required to transport the coke breeze from a storage bin to the soaking pit.

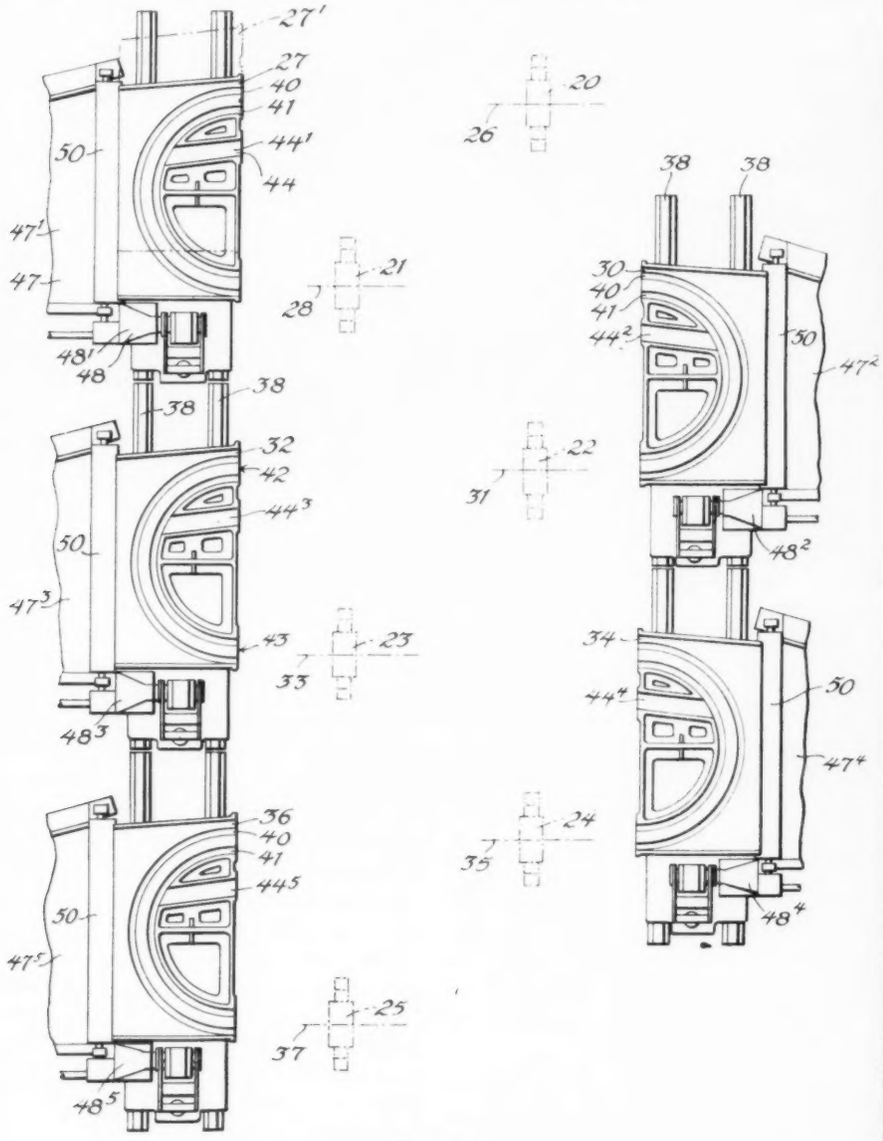
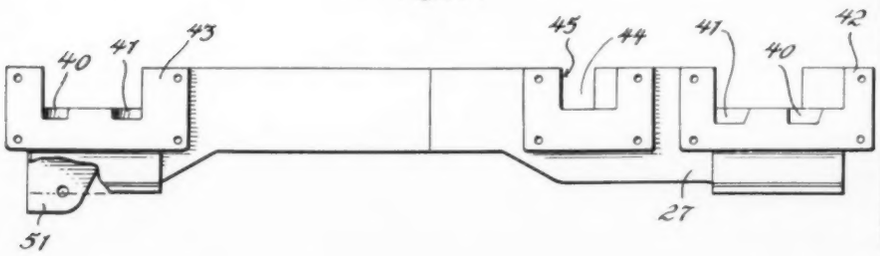
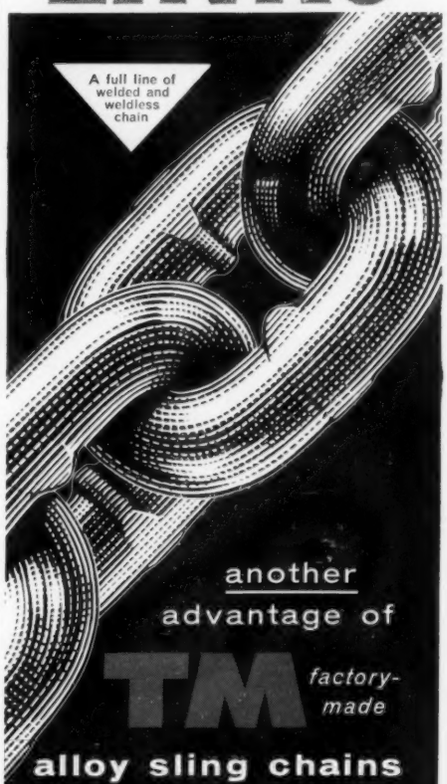


Figure 6

Figure 7



STRESS FREE LINKS



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In the making of bottoms in an ingot soaking pit, coke breeze is spread over the floor of the pit to a depth of from 12 to 16 in. The coke breeze for this purpose is commonly transported to the pit in a cylindrical bucket which is suspended from the ingot tongs of the pit crane. When positioned over the pit, the bucket is rotated and moved along the pit by the crane while its contents are being discharged to spread the coke breeze over the floor of the pit. The distribution of the coke breeze in this manner is very irregular and leveling by dragging the bucket or a spade or other tool, usually suspended from the ingot tongs, over the surface of the coke breeze bottom is generally necessary. This requires considerable skill on the part of the crane operator and frequently results in damage to the refractory pit walls from accidental contact with the bucket or spreading tool. In addition, it is usually necessary for the crane to make several trips to supply the coke breeze required for making bottom and the pit cover must be removed for each delivery of coke breeze by the crane and charging bucket. The frequent removal of the pit cover is a source of considerable heat loss during the replacement of pit bottoms.

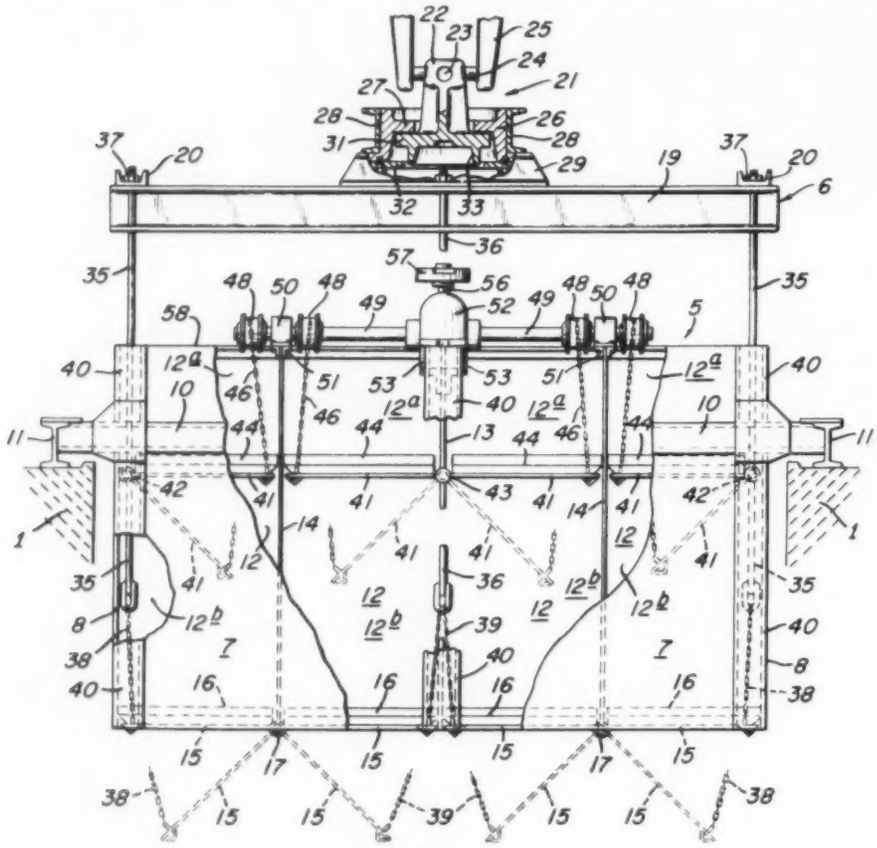
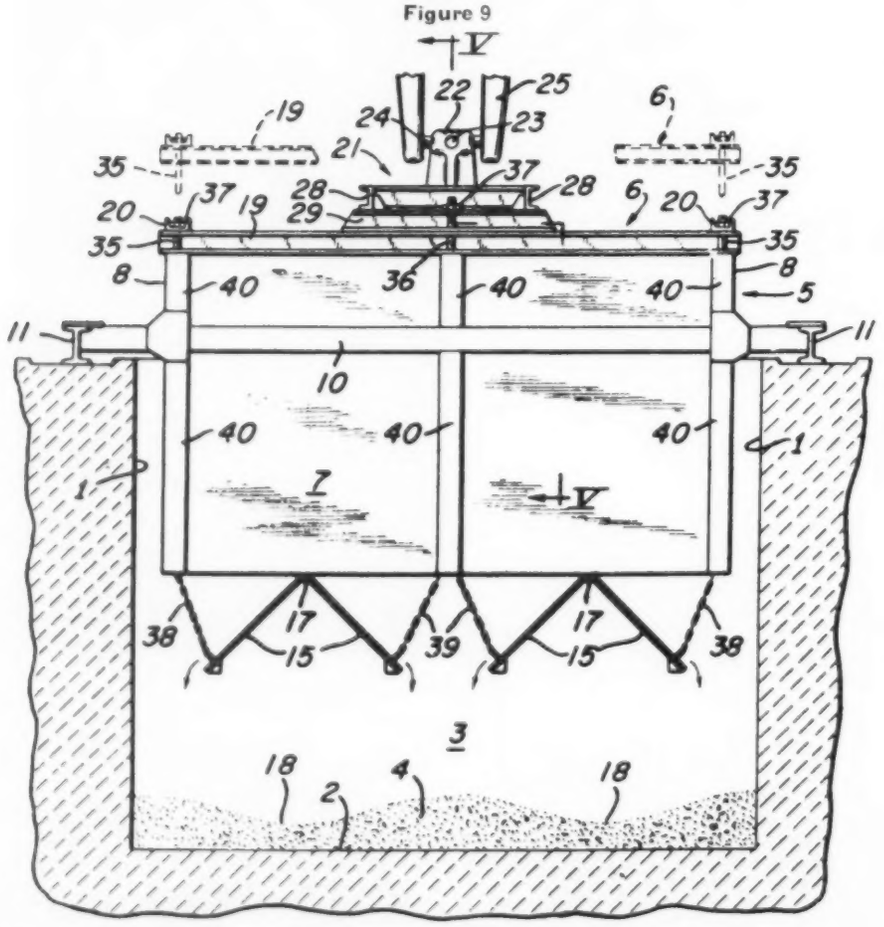


Figure 8

Figure 9



Upon arrival at the soaking pit, the container 5 is placed in position over one end of the soaking pit, as shown in Figures 8 and 9. With the end beams 11 supported on the sidewalls of the pit, movement of the lifting frame 6 to the position shown in Figure 9 releases the doors 15 for movement to their open positions and the coke breeze in the compartments 12b is discharged onto the floor of the soaking pit. This operation covers one-half the area of the soaking pit floor with a coke breeze bottom 4. The container 5 is then lifted by the ingot tongs 25 and moved to a position supported by its end beams 11 over the other end of the soaking pit. The lifting frame 6 is then lowered to engage the clutch elements 33 and 57, and upon operation to move the doors 41 to their open positions, coke breeze in the compartments 12a will flow downwardly through the compartments 12b onto floor of the soaking pit.

It will thus be apparent that the container 5 enables making of a coke breeze bottom on the floor of a soaking pit by a single trip from the coke breeze storage facilities. The provision of the second set of doors 41 eliminates the necessity of a second trip of the container.

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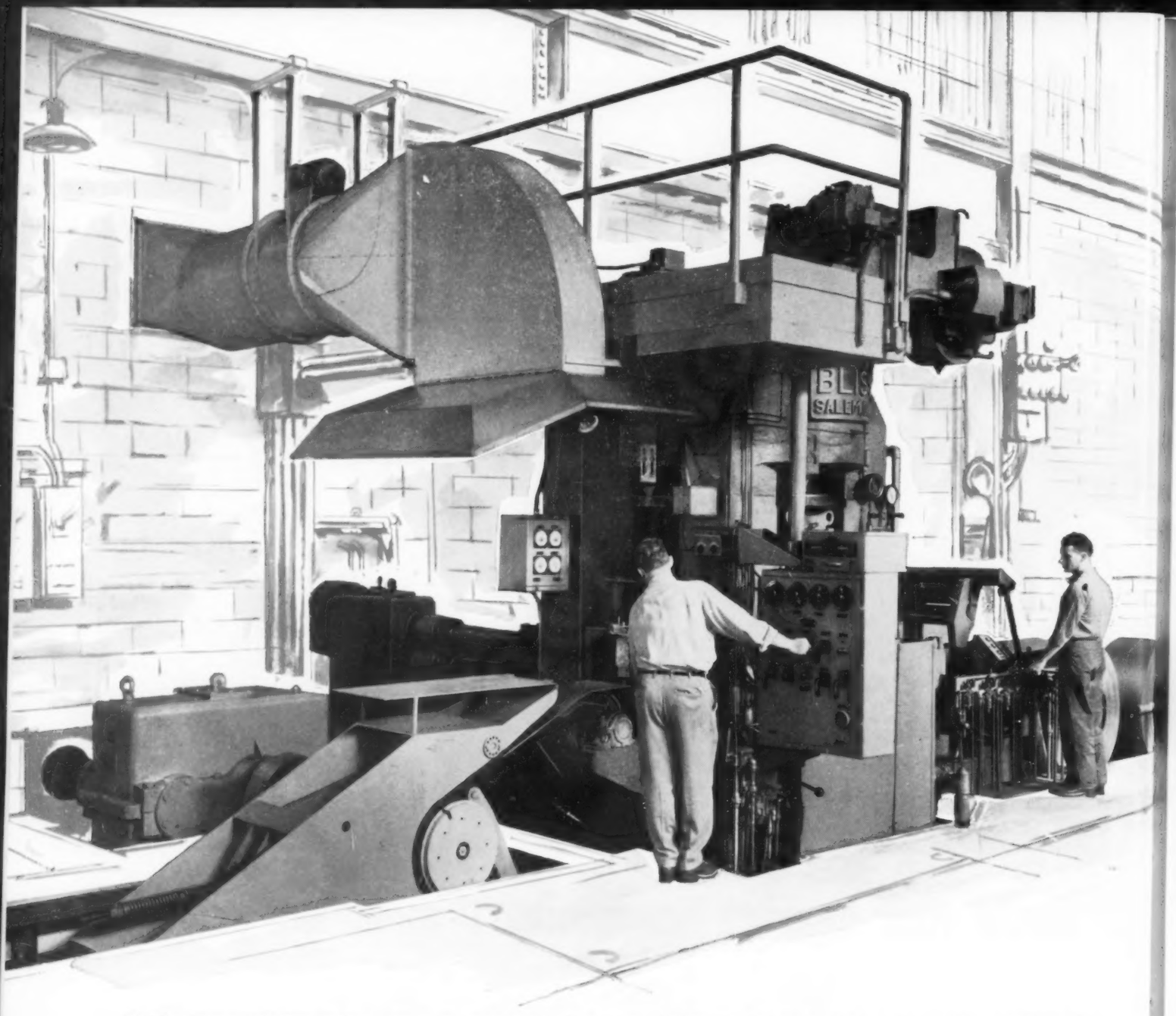

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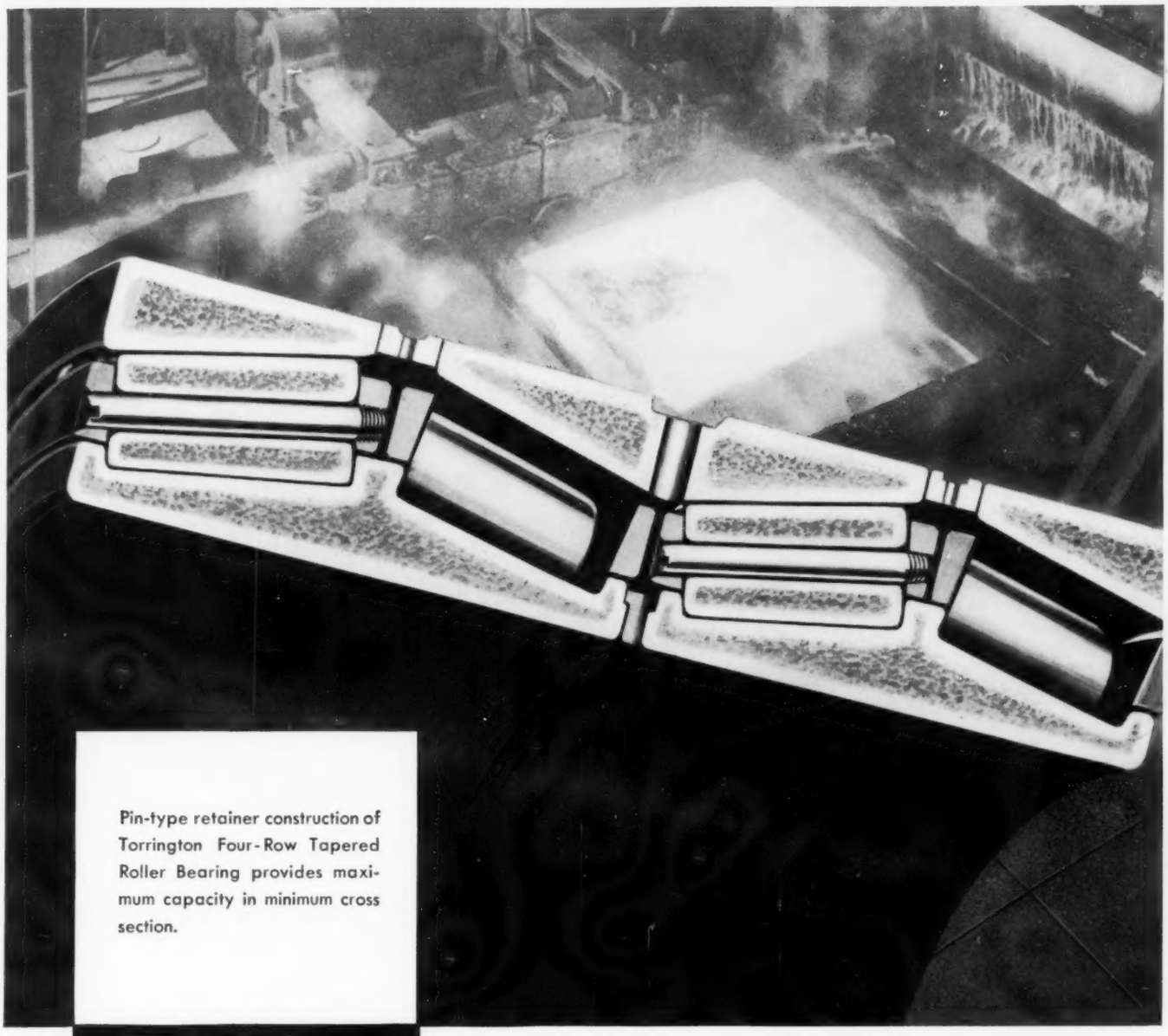
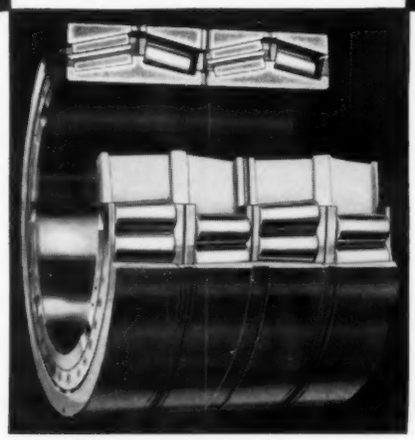


Pin-type retainer construction of Torrington Four-Row Tapered Roller Bearing provides maximum capacity in minimum cross section.



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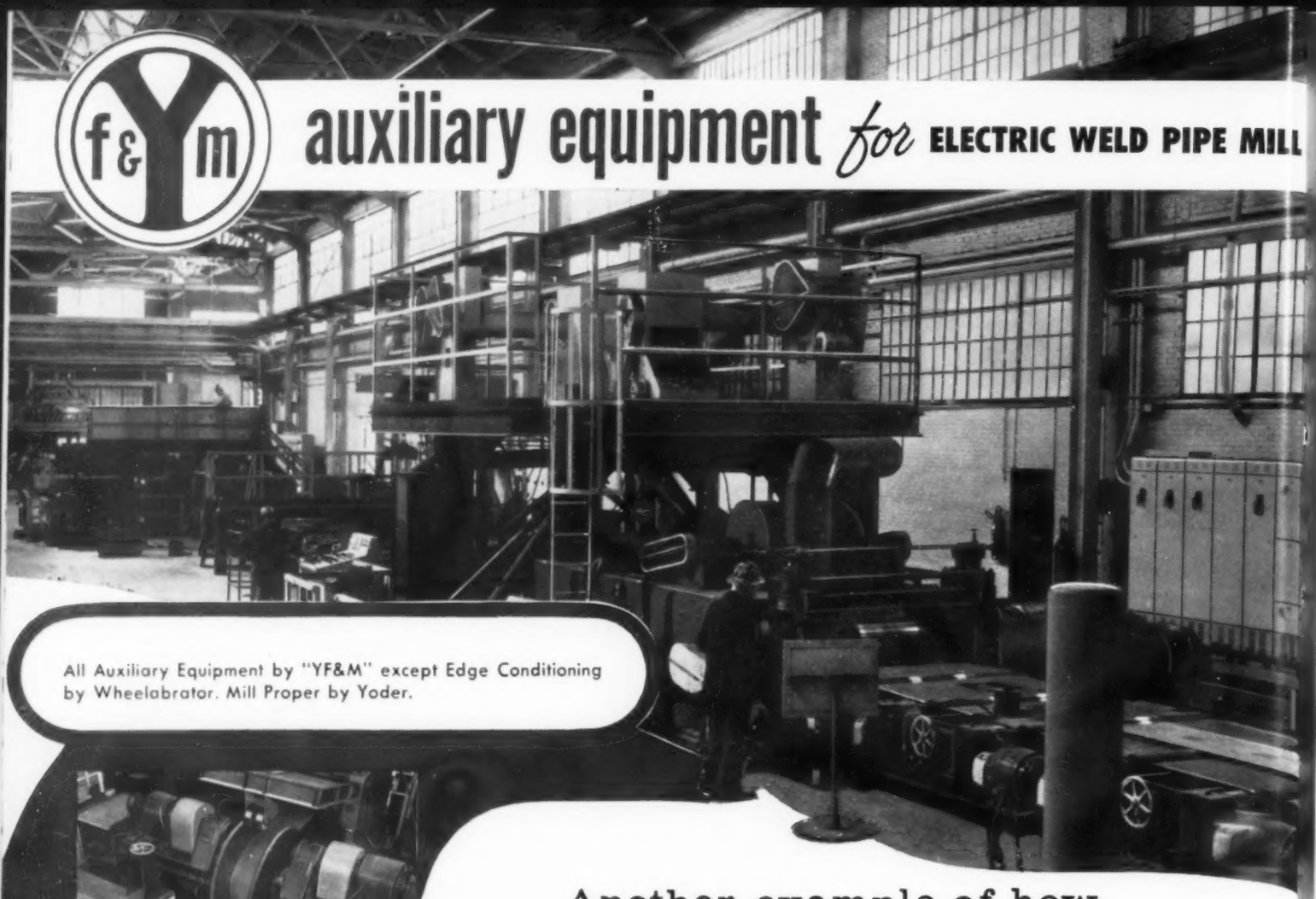

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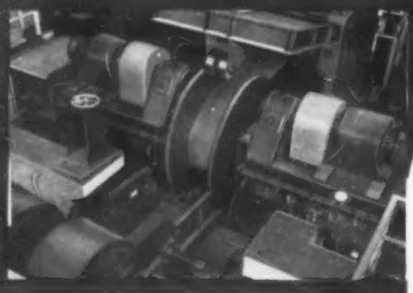

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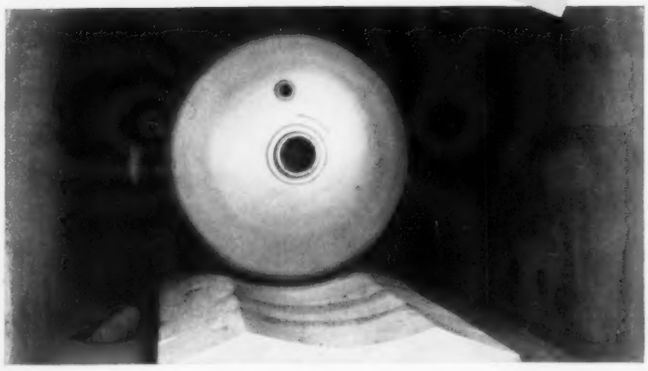

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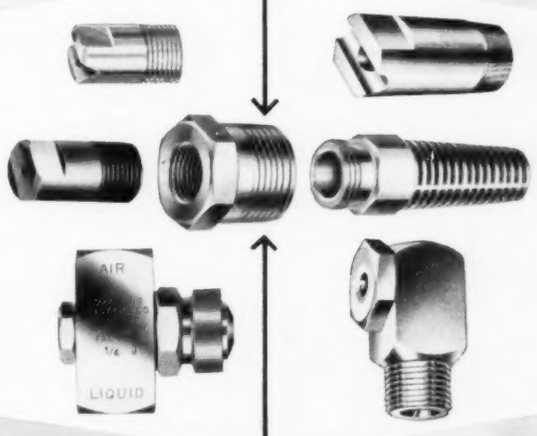

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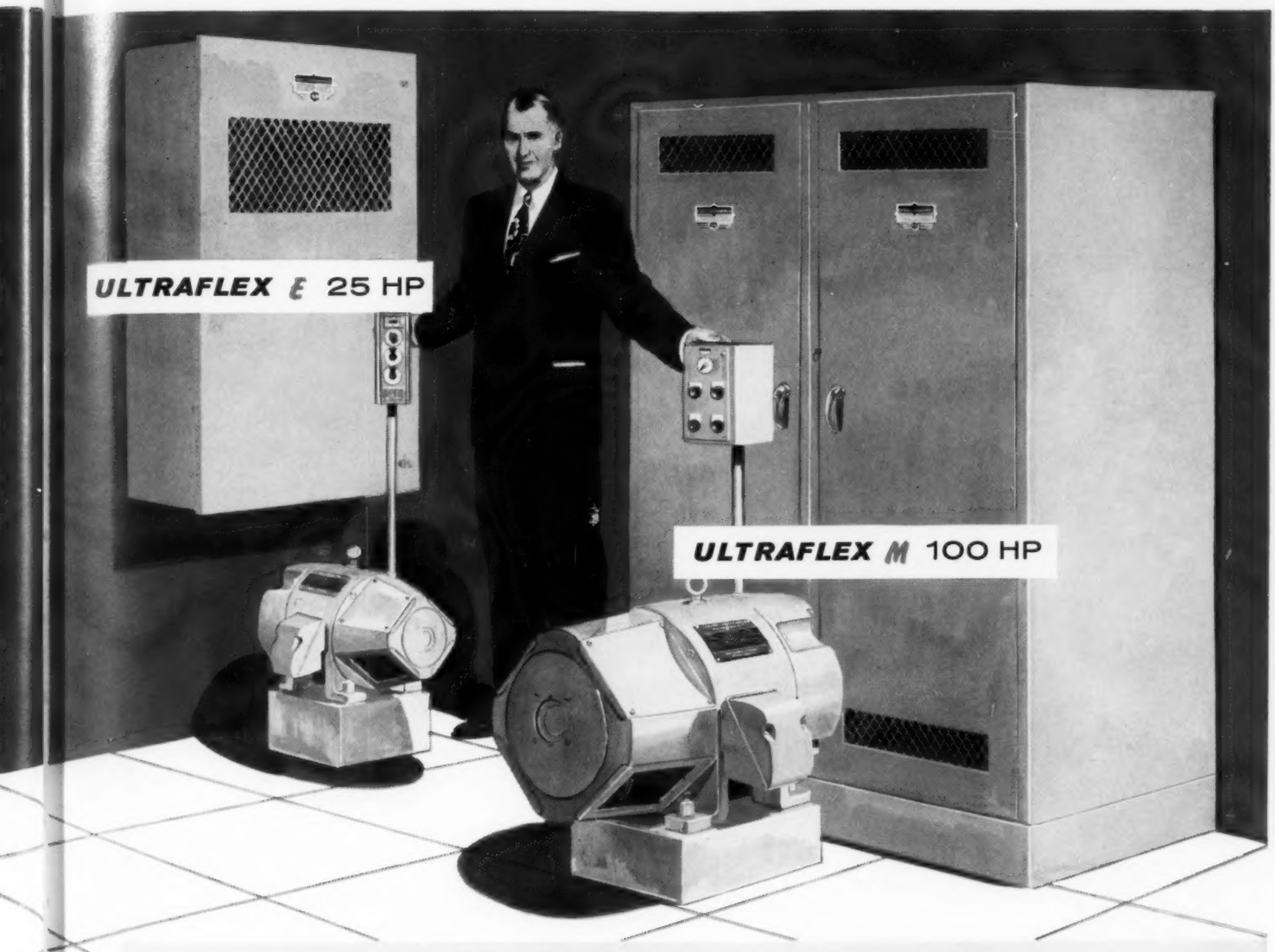

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10	5.44	647	Wall Mounted	215
15	7.0	983	Wall Mounted	330
20	9.5	1830	Wall Mounted	330
25	9.5	1990	Wall Mounted	330
30	9.5	2120	6.46	625
40	13.8	2350	6.46	625

HP	CONVENTIONAL m-g DRIVES SQ. FT.	CONVENTIONAL m-g DRIVES LBS.	ULTRAFLEX—M SQ. FT.	ULTRAFLEX—M LBS.
5	3.89	543	3.5	660
7½	3.89	550	3.5	870
10	5.44	647	3.5	870
15	7.0	983	3.5	1000
20	9.5	1830	3.5	1000
25	9.5	1990	4.5	1250
30	9.5	2120	4.5	1250
40	13.8	2350	4.5	1250
50	17.8	2980	11.7	2200
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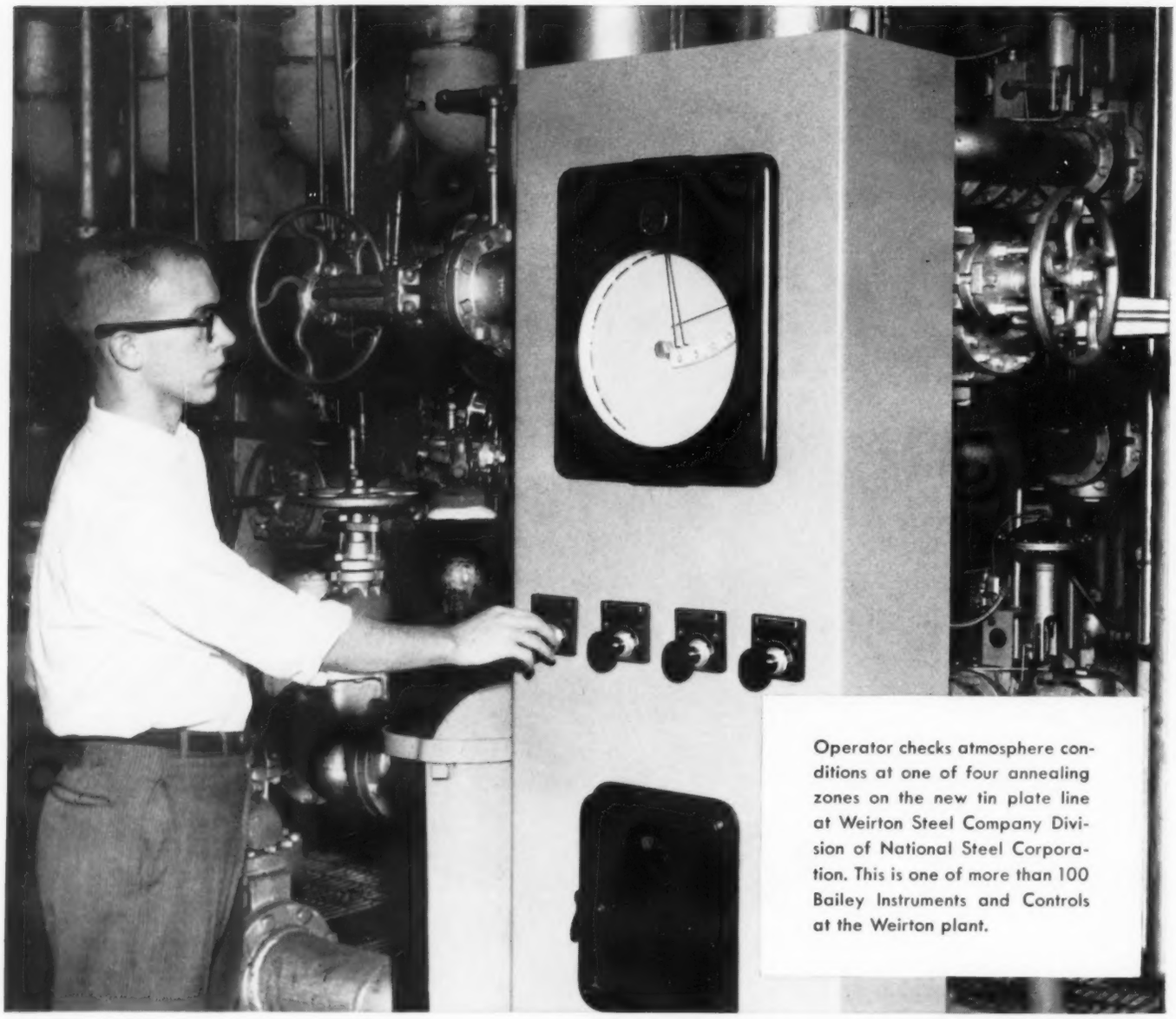

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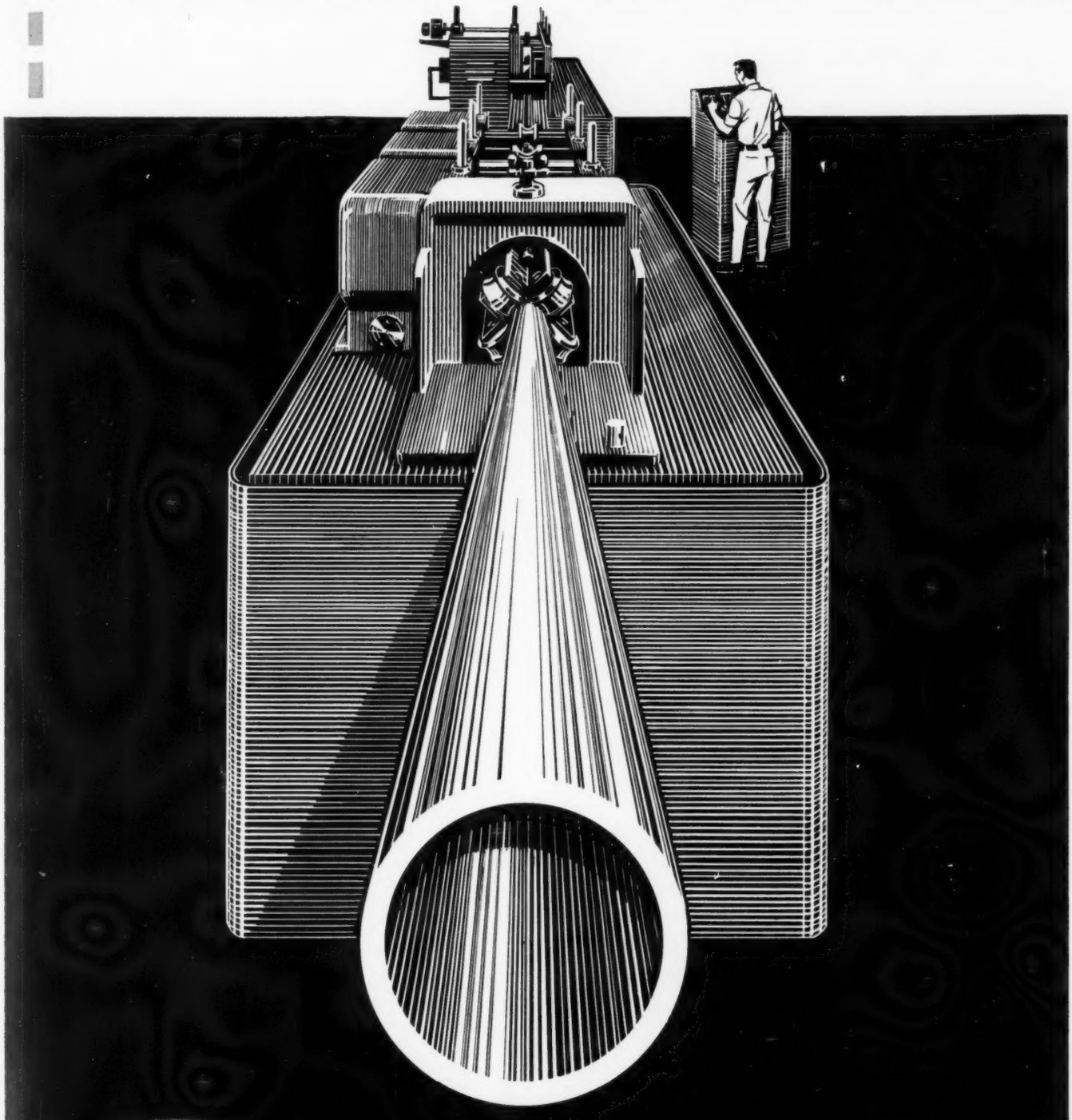

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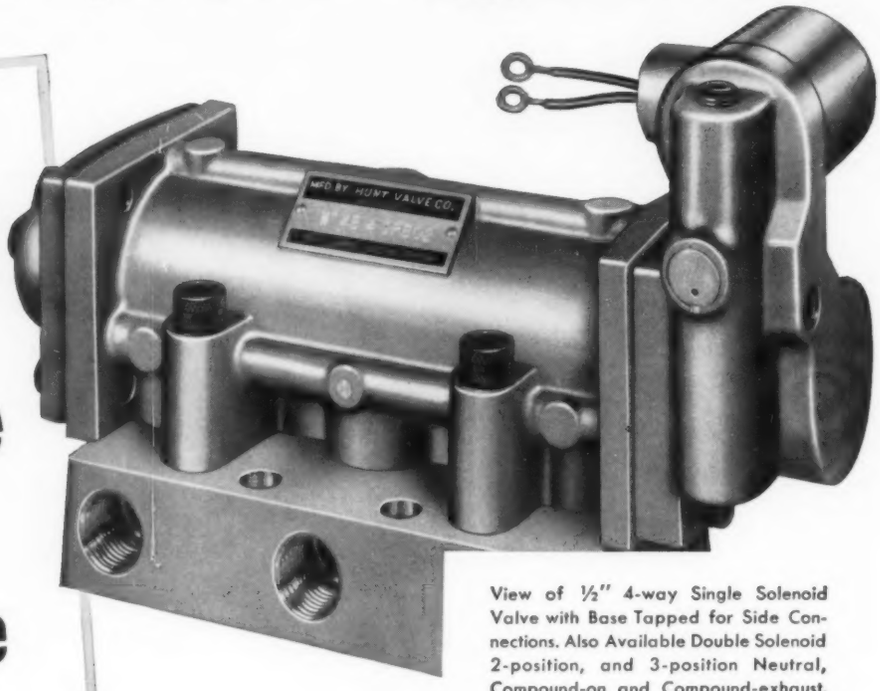

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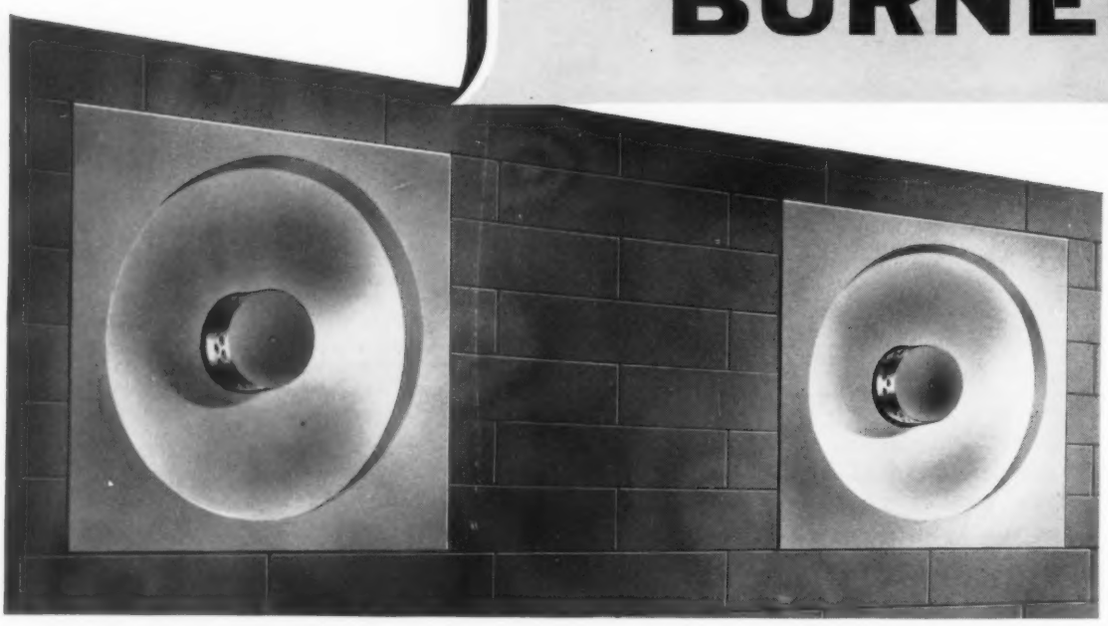

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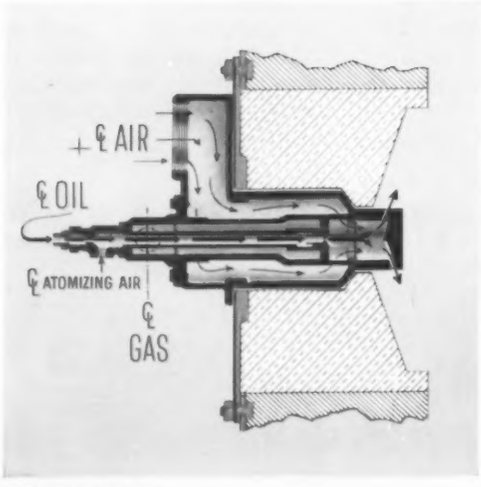

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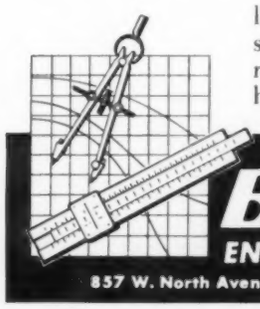

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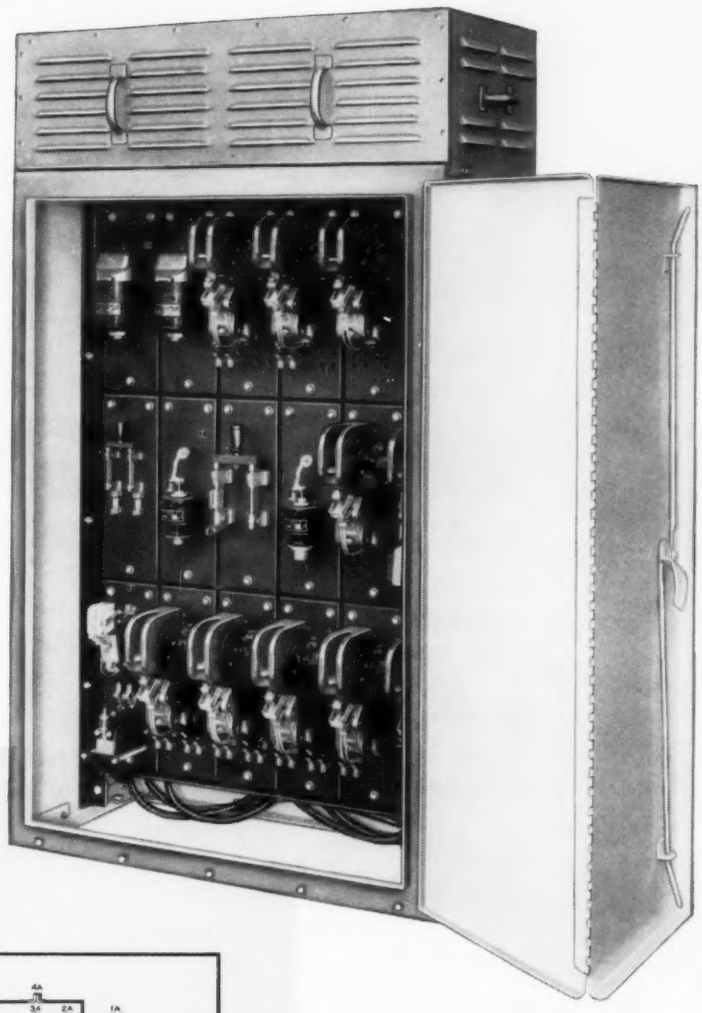

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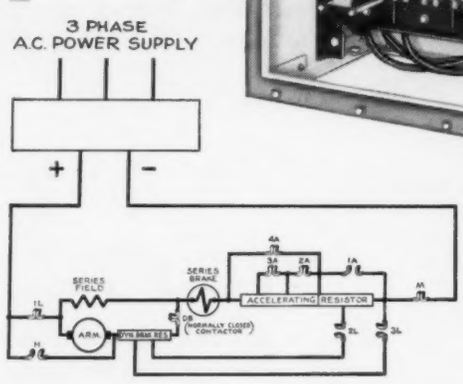

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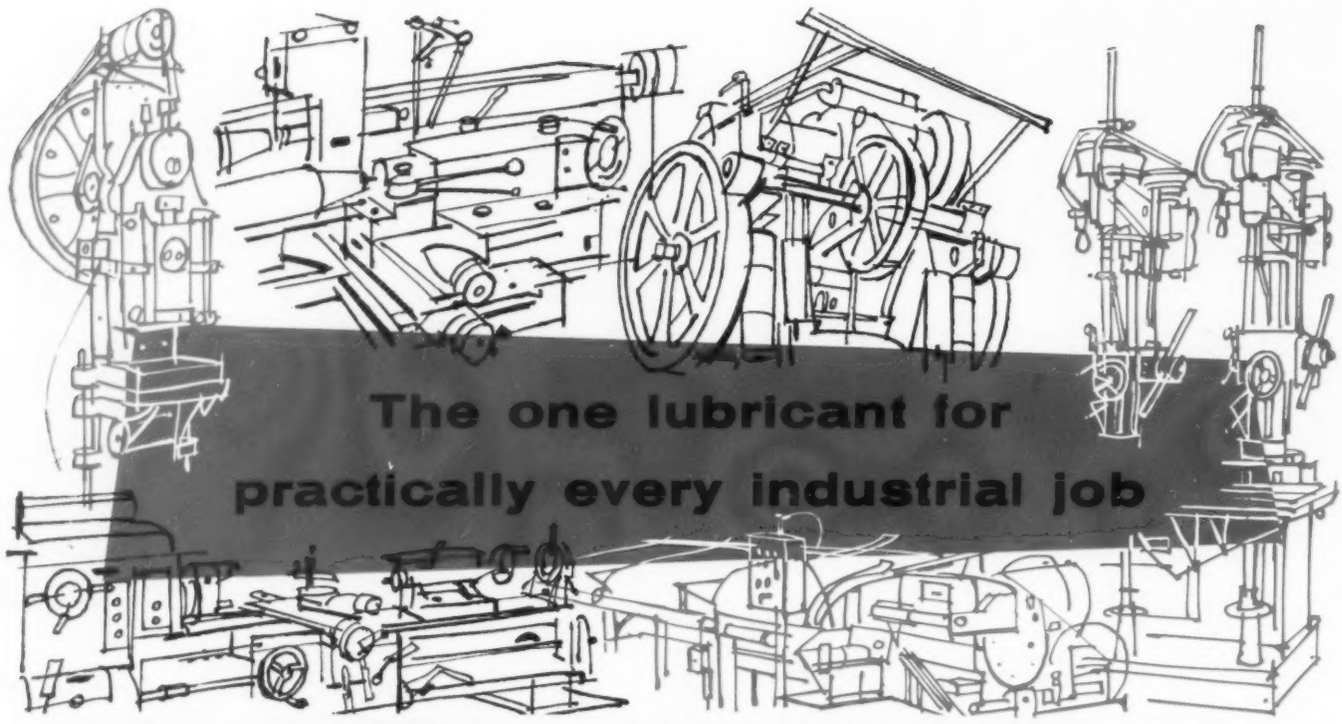

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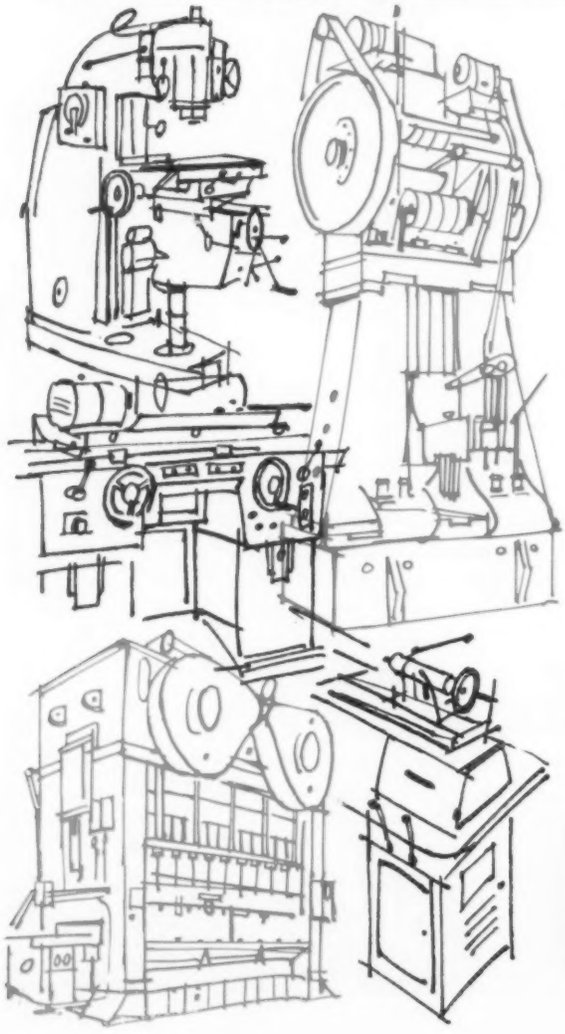

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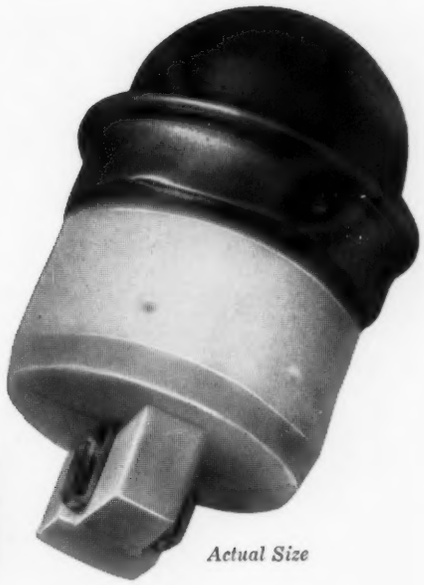

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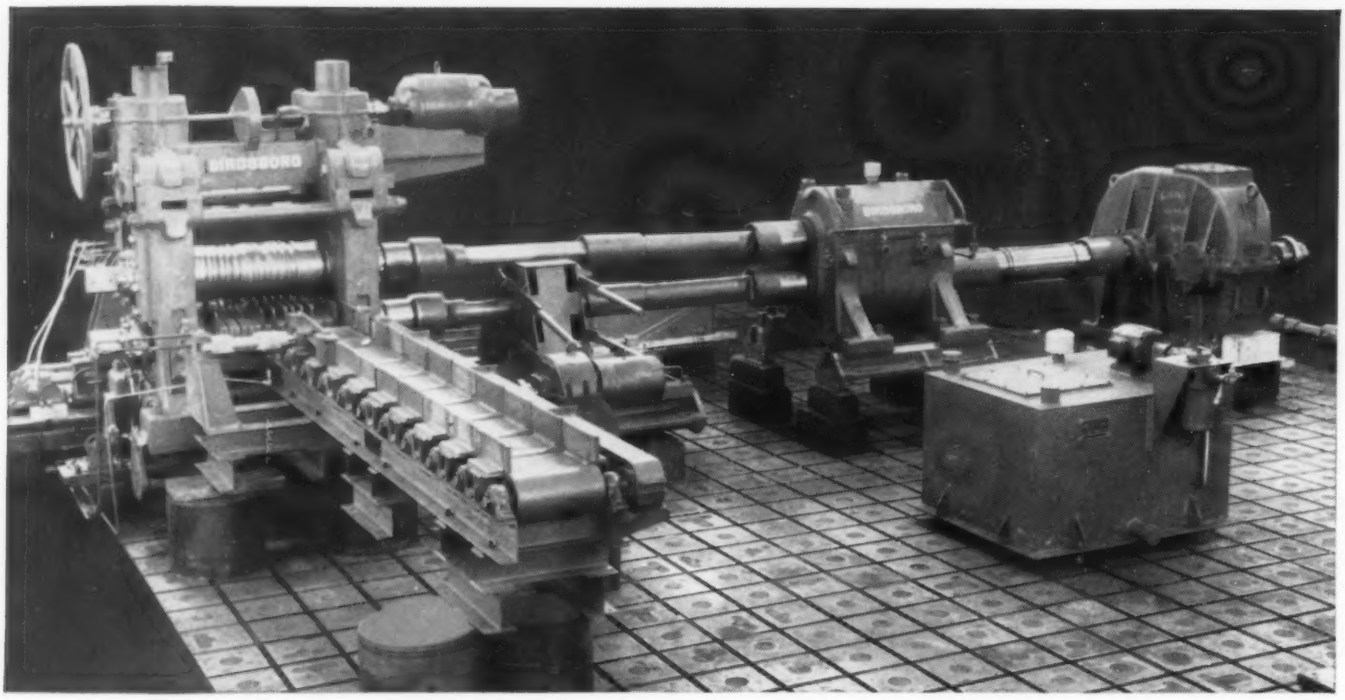

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Foreign Digests

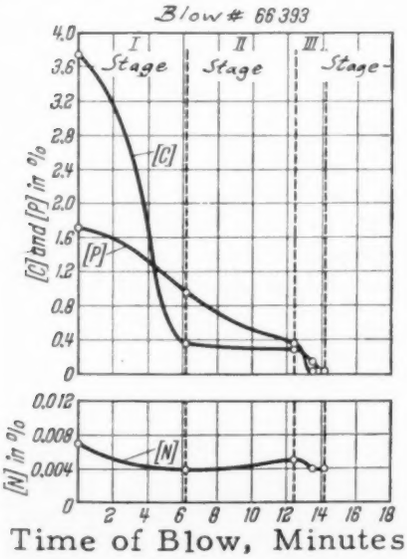
Complete translations for which these condensations were prepared are available from Henry Brutcher, P.O. Box 157, Altadena, Calif., to whom all correspondence should be addressed.

"THE PHOENIX OXYGEN-LANCING PROCESS"

by H. TH. BRANDI, Phoenix-Rheinrohr AG., Ruhrort. (Translation No. 4270 from Stahl und Eisen, Vol. 78, 1958, No. 13)

Δ EXPERIMENTS carried out at Ruhrort have led to commercial use of a new process, based on the basic converter process in the bottom-blown converter. The metallurgical task is to avoid the disadvantages (especially nitrogen pickup during dephosphorization) of the classic process while maintaining its advantages. Metallurgically speaking, the problem is to displace the oxidation of carbon wholly or in part to a stage of the blow that follows dephosphorization so as to utilize the flushing action that is associated with carbon elimination. The process is called the Phoenix lance process.

Figure 1 — Reactions to (C), (P), and (N) in the PL process.



The new process (patent applied for) is carried out in the normal basic lined vessel, but the converter is not only bottom-blown in the upright position but is from time to time used in the horizontal position to allow metal-slag reactions to take place as in the open hearth furnace.

The operation of the PL process will be seen from the reaction diagram of a heat. In the first stage of the process (Figure 1), basic bessemer pig iron is bottom-blown to reduce the carbon content to 0.4 to 0.1 per cent. In the second stage, the converter is briefly turned into the horizontal position.

A water-cooled lance is introduced into the mouth of the horizontal converter. Oxygen is blown through the lance, causing rapid fusion of slag-building materials. Thus, apart from a limited removal of carbon, phosphorus passes into the slag at a lively rate. The vessel is then turned into the upright position for a short time and blown with air blast or oxygen-enriched blast. This lowers the phosphorus content in a few seconds to 0.020 to 0.040 per cent while the carbon content of the steel bath can be brought to 0.02 to 0.10 per cent and, if necessary, even to higher contents.

Phosphorus can be brought down to specially low values by introducing a second slag. The main or primary slag (slag after the third stage of the process but before final dephosphorization corresponds to a normal slag from basic converters and therefore yields the usual fertilizer.

With the PL process, it is possible to effect dephosphorization generally as in the open hearth furnace and carbon contents at the end of the actual refining process are of the same order as those of the open hearth process. Therefore, the nitrogen and oxygen problem is solved. The nitrogen content of PL steel ranges from 0.003 to 0.005 per cent and the carbon content is similar to that of open hearth steel or of LD steel, depending on the carbon content of the steel bath at the end of refining.

The degree of desulphurization is from 70 to 80 per cent.

The total time of blow is about 15 minutes, only slightly longer than that of the conventional basic bessemer process. Oxygen consumption is about 2250 cu ft per net ton of pig iron and is more than half covered by oxygen from the air.

"EFFECT OF BASICITY OF FLUXED SINTER UPON COKE CONSUMPTION AND PRODUCTION OF BLAST FURNACES"

by I. B. STRASHNIKOV, A. G. ASTAKHOV, G. H. KSENDZYK, N. V. FEDOROVSKII and K. A. SHUMILOV, Institute for Ferrous Metallurgy and Mining, Ukrainian Academy of Sciences. (Translation No. 4298 from Stal', Vol. 18, 1958, No. 5)

Δ PARTIAL replacement of raw limestone by self-fluxing sinter in the blast furnace charge reduces

TABLE I

Effect of Sinter Basicity upon Furnace Performance

No.	Period of runs	Furnace No.	Contents of sinter, %		$\frac{CaO}{SiO_2}$	Drop in limestone used, %	Drop in coke consumed, %	Increase in iron production, %	Increase in iron yield per unit of coke, %
			CaO	SiO_2					
	Dzerzhinskii Metallurgical Works								
1*	July 8–12, 1951	8	5.60	12.90	0.43	10.0	1.0**	− .06	− 0.4
2	February/April, 1955	10	5.88	14.96	0.39	16.0	0.0	− 5.5	0.6
3	January to April, 1955	8	6.60	11.67	0.57	16.8	7.1	7.3	7.6
4	January/November, 1955	9	6.80	13.90	0.49	20.2	0.0	0.8	− 1.45
5	August/October, 1953	1	5.66	19.50	0.29	20.0	1.8	− 0.1	− 3.27
6	December, 1954/November, 1955	7	7.69	11.45	0.67	23.9	3.3	7.1	5.39
7*	July 8–13, 1952	6	15.73	13.37	1.18	100.0	11.8**	11.5	20.40
8*	December 14–18, 1952	6	20.45	13.30	1.54	100.0	12.0**	− 0.55	13.83
	Krivoi Rog Metallurgical Works								
9	June 14–23, 1953	1	9.50	14.50	0.66	33.0	3.6**	− 0.8	− 1.20
10	August/December, 1954	1	...	...	0.5–0.6	34.3	4.1	4.3	4.97
11	January, 1955	1	9.68	15.60	0.62	32.1	− 2.5	0.05	− 2.5
12	February, 1955	1	12.50	14.60	0.86	59.5	4.3	1.4	4.5
13	March, 1955	1	12.53	13.80	0.91	58.4	9.8	1.9	10.5
14	April/November, 1955	1	...	...	0.55	39.4	9.7	5.6	10.5
15	December, 1955	1	9.22	15.23	0.61	52.5	9.1	4.4	9.6
16	January/March, 1956	1	...	...	0.63	58.9	14.1	10.4	15.7
17	April, 1956	1	15.16	13.20	1.15	94.7	19.0	15.2	23.8
18	May, 1956	1	9.19	14.62	0.63	68.2	13.5	11.3	15.2
19	June/December, 1956	1	...	...	0.64	59.4	12.4	8.3	14.2

* Sinter fluxed with chalk of 0 to 10 mm. (0 to $\frac{25}{44}$ in.) particle size.

** With correction for identical operating conditions of the blast furnace for ordinary and fluxed sinters.

the amount of heat used for decomposing the limestone and for the endothermic reaction between carbon dioxide and the carbon of the coke. Consequently, with an increase in sinter basicity and a reduction in the consumption of raw limestone, coke consumption per ton of iron must accordingly be reduced. Minimum coke consumption per ton of iron will be attained with sinter basicity which permits the complete elimination of raw limestone from the blast furnace charge.

Both trial and production blast furnace runs using self-fluxing sinter completely confirm these considerations (see Table I).

The table also presents data on the variation in blast furnace productivity when changing over from normal to fluxed sinter. There is apparently no clear relationship between the basicity of fluxed sinter and furnace productivity as there is between basicity and coke rate.

The basic factors determining blast furnace productivity, other things being equal, are burden ratio and intensity of coke combustion (rate of smelting), which exhibit a straight-line relationship with furnace productivity.

The data show that, in most periods, the change over to fluxed sinter led to an increase in the output of pig iron per unit of coke and this was especially the case in those runs made with sinter of high basicity, and with complete omission of limestone from the blast furnace charge. In cases of normal operation with fluxed sinter, the ore charged per unit weight of coke can be increased as the basicity of the sinter increases, requiring less limestone in the charge.

High basicity fluxed sinter exerts a favorable effect on coke consumption per ton of iron and on the ore/coke ratio, and has a negative effect on the rate of coke combustion.

The rate of coke combustion in the blast furnace is determined, other things being equal, by the gas permeability of the stock column. Particle size distribution of the sinter has a marked effect on the gas permeability of the stock column.

With a high calcium oxide content, the screen analysis of sinter undergoes a marked deterioration compared with normal or low basicity sinter. Even with a sinter basicity of 0.5, the +1 in. fraction after the drum tests is somewhat less than in normal sinter. With a basicity of 1.18, it is reduced to 12 per cent, while with a basicity of 1.54, the +1 in. fraction is reduced to 7.1 per cent, which is about a quarter of that of normal and low basicity fluxed sinter.

Thus, a deterioration in the screen analysis of high basicity fluxed sinter must be regarded as the main cause of a reduced rate of coke combustion when operating with this type of sinter.

However, a similar reduction in the rate of smelting is also caused by other factors, especially an increase in the ore charge which is inevitably associated with an increase in the amount of fines and in the slag volume per unit volume of coke, and consequently also with a deterioration in gas permeability of the charge at the upper and lower levels of the furnace.

As a result of this, a certain reduction in the rate of coke combustion can be expected when changing over to high basicity sinter, even in cases where this sinter does not differ in its screen analysis from ordinary sinter.

Coke consumption per ton of iron when smelting fluxed sinter is determined by the ore/coke ratio, being inversely proportional to sinter basicity. Under the conditions obtaining at south Russian plants, maximum savings on coke (ranging from 12 to 14 per cent) are possible when raw limestone is omitted entirely from the blast-furnace charge.

The rate of coke combustion depends on the screen analysis of sinter, and increases with an increase in

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the quantity of coarse fractions in the sinter.

Blast furnace productivity is determined by the relationship between ore/coke ratio (which increases with increasing sinter basicity) and the rate of coke combustion in the furnace (which decreases with increasing sinter basicity due to a reduction in the amount of coarse fractions in the sinter).

Measures must be taken to improve the screen analysis of high-basicity sinter of the fluxed type, as regards the small amount of coarse fraction in the sinter and the considerable amount of fines.

It must be recognized that the basic criterion of fluxed sinter quality is the amount of coarse fraction (+ 1 in.) after the drum test and not the amount of the 0 to ¼ in. fraction, which does not give a true picture of the suitability of fluxed sinter for the blast furnace.

"A BLAST-FURNACE TOP DISTRIBUTOR OF NEW DESIGN"

by A. S. AYUKOV. (Translation No. 4309 from Stal', Vol. 16, 1956, No. 11)

△ DISTRIBUTION of the materials at the top of a blast furnace should be as uniform as possible around the periphery of the large bell. In addition, the distributor should provide a reliable seal, especially in view of the drive to increase gas pressures in blast furnaces. Even at the relatively low pressure of 8.8 to 10.3 psi used at present, it is no easy matter to get a satisfactory seal with distributors of present design.

The distributor which has been fitted in Russia to all new blast furnaces has a number of defects because of the need to rotate with a powerful electric motor the small bell, its rod and hopper, filled with burden. Special packings have to be used at the points of contact of the rotating and fixed parts, and the design of the support of the rod for the small bell is rather complicated.

All this makes the charging equipment expensive and causes a number of difficulties and complications in its use, particularly with high gas pressures inside the furnace. Hence a new top distributor has been worked out in which these disadvantages of the present design have as far as possible been eliminated.

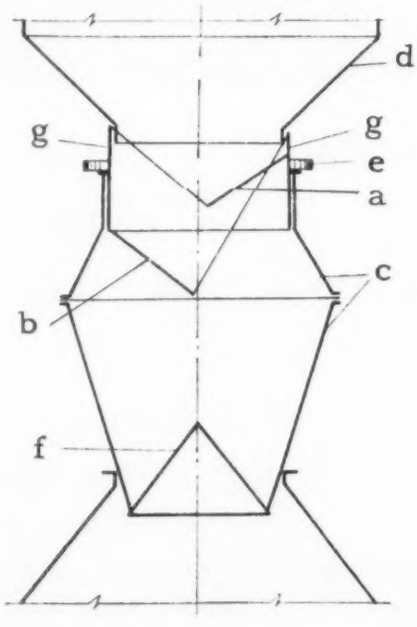
The proposed distributor (Figure 1) is a ring (*g*) divided along its generating line; one half of this has a baffle (*a*), and the other a guide chute (*b*) disposed under different conditions at an angle of 45 degrees to the internal surface of the hopper (*c*) on the small bell (*f*). The baffle and guide are half-cone sections.

The distributor is made of cast steel. It is arranged between the receiving hopper (*d*) and the hopper of the small bell and can be freely rotated by an electric drive (*e*). The stationary hopper of the small bell consists of two parts. The upper part is divided along a generating line to simplify fitting and also the removal of the distributor. Materials are distributed by rotating the ring with the baffle and guide. All the skips of one charge are unloaded with the baffle and guide in the same station. After the materials have been discharged from the large bell into the furnace, the distributor is moved to receive the succeeding charge at another station.

Tests made on a 1 to 25 scale model showed that, in charging on a complete cycle, the proposed distributor yields as uniform a distribution of materials on the periphery of the large bell as the one presently used.

In addition, a powerful electric motor is not needed for rotating the new distributor. The small bell, its rod and hopper, filled with materials, are not rotated.

Figure 1—This top distributor was designed by A. S. Ayukov.



A drawback of the new distributor is the great height (6½ to 8¼ ft) of the hopper of the small bell, but this cannot be considered an obstacle to fitting it on new furnaces.

The proposed top distributor ensures reliable sealing of the charging equipment and is operationally reliable at high blast furnace top pressures. It is simple in construction and consumes considerably less electrical energy than the presently used distributor.

The new distributor does not necessitate packing nor a complicated design of the support of the rod for the small bell.

With the new distributor the distribution of materials around the periphery of the top can be effectively controlled, and therefore also the flow of gases in the furnace.

OTHER AVAILABLE TRANSLATIONS

"Top Blowing with Oxygen in Basic Converter," S. I. Lifshits and S. G. Afanas'ev. Metallurg, May, 1958, no. 5. Description of basic converter department of Petrovsk steelworks. General layout; design of vessels; oxygen-lancing arrangement; lining refractories. Operational details; hot metal composition; blowing and lancing practice; ore, lime, and bauxite additions; oxygen consumption; C, P, and Si oxidation; metal and slag reactions and compositions; bath temperature during blow; composition of converter gases. Daily production of department increased 120 N.T. after adoption of oxygen lancing. (Translation No. 4267)

"Lining of Top-Blown Oxygen Converters at Donawitz Steelworks," A. Wegscheider. Stahl und Eisen, vol. 76, 1956, no. 10. Survey of development work on linings and lining materials for top-blown oxygen converters, covering the period of 1953 to 1956. First experiments with Austrian dolomitic magnesite. Performance of preburned and of green brick bonded with tar; tar-dolomite brick compared with tar-magnesite brick. Trials with various linings including special and ordinary fired magnesite brick, and lining lives attained; data on brick consumption for lining. (Translation No. 3783)

NATIONAL stopped brush breakage!

TRADE-MARK

DOWN-TIME COULD HAVE COST THIS POWER COMPANY A FORTUNE!

"RED" BLACKBURN

Power companies kept reporting threading and grooving of the steel field rings on giant turbine generators. The result was eccentric rings and *severe brush breakage,* says "National" Carbon Brush Man "Red" Blackburn.

And, he continues, a turbine off the line for reconditioning can cost a fortune in power replacement — not to mention repair expense.

"Red" suggested using "National" Grade 634 Brushes. Comparative tests showed this brush eliminated threading, grooving and resisted breakage and chipping when applied to eccentric rings.

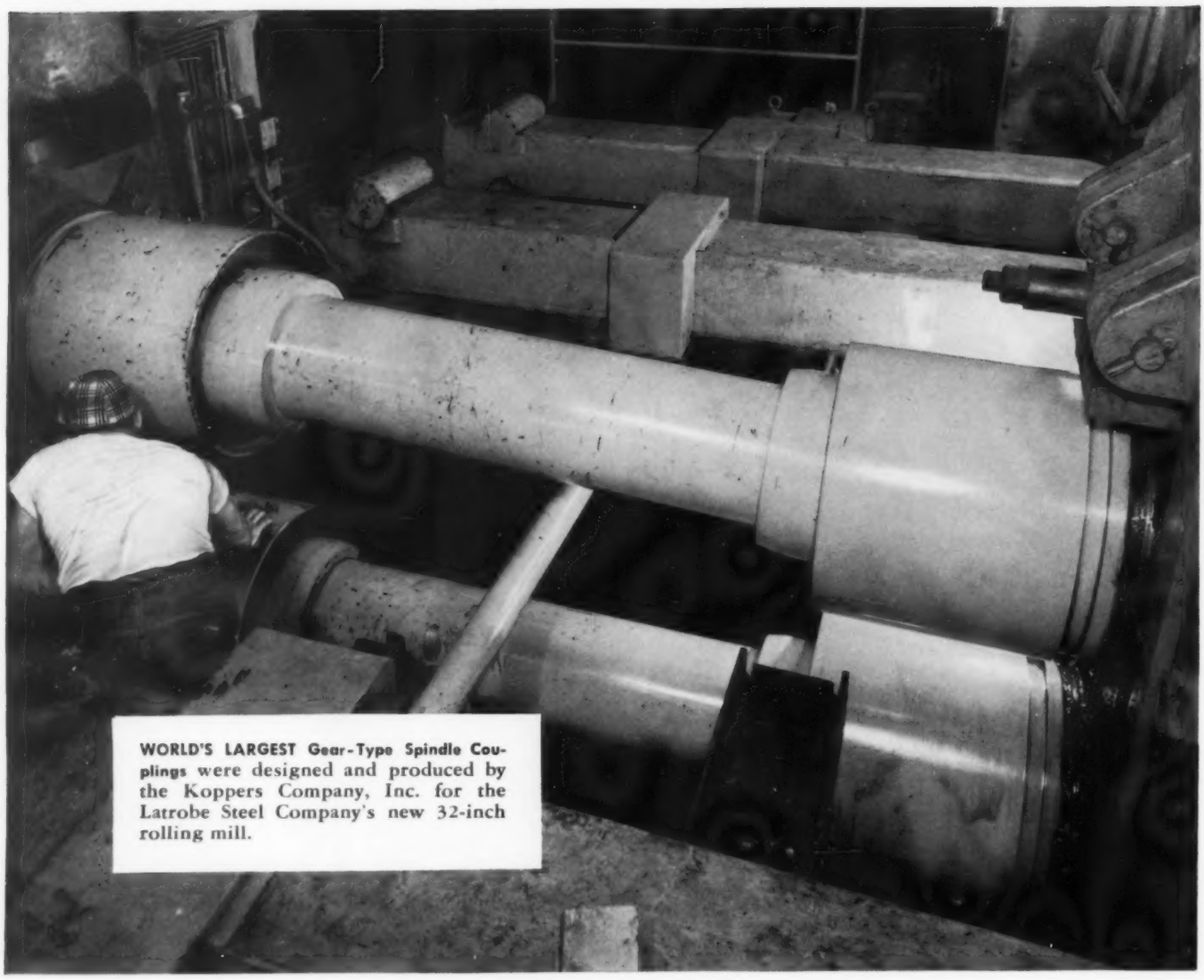
Do you have a brush problem? Call *your* "National" Brush Man. Or, write to National Carbon Company, Division of Union Carbide Corporation, 30 East 42nd St., New York 17, N. Y.

UNION CARBIDE

"National", "N" and Shield Device and "Union Carbide" are registered trademarks of Union Carbide Corporation

NATIONAL CARBON COMPANY • Division of Union Carbide Corporation • 30 East 42nd Street, New York 17, N. Y.

Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco. *In Canada:* Union Carbide Canada Limited, Toronto.



WORLD'S LARGEST Gear-Type Spindle Couplings were designed and produced by the Koppers Company, Inc. for the Latrobe Steel Company's new 32-inch rolling mill.

Fast's 5-Ton Spindle Couplings Speed Rolling Mill Changes

The world's largest gear-type spindle couplings, designed and built by Koppers, help solve critical production problems in the manufacture of superalloy steels.

Down-time in rod, bar, rolling and blooming mills can be reduced as much as 50% with Fast's Spindle Couplings. Their quick-disconnect and quick-assembly feature can lead to savings up to thousands of dollars a week.

A new tooth configuration compensates for a relatively high amount of misalignment with a minimum of backlash. It also provides constant angular velocity which results in a marked improvement in the quality of the end product.

Fast's Spindle Couplings are made of all steel with a metallic segmented conformable, self-lubricating seal. They give years of trouble-free service under the most adverse operating conditions with only a minimum of maintenance.

Nearly 40 years of experience in the steel industry guarantees that Koppers can supply the right coupling engineered for a given application. To solve your coupling problem, write KOPPERS COMPANY, INC., Fast's Coupling Department, 3001 Scott Street, Baltimore 3, Maryland.

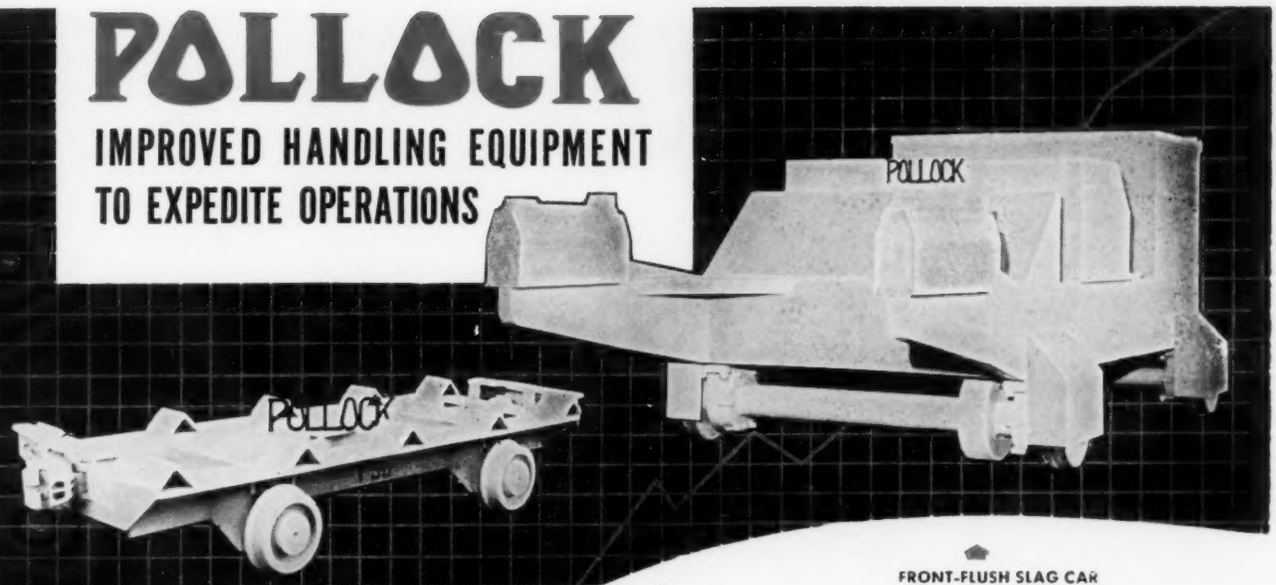
Engineered Products
Sold with *Service*

KOPPERS

THE ORIGINAL
FAST'S Couplings

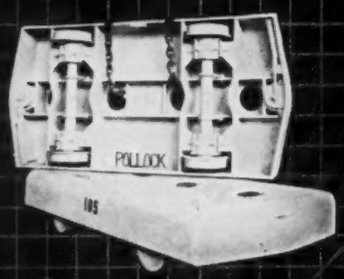
POLLOCK

IMPROVED HANDLING EQUIPMENT TO EXPEDITE OPERATIONS



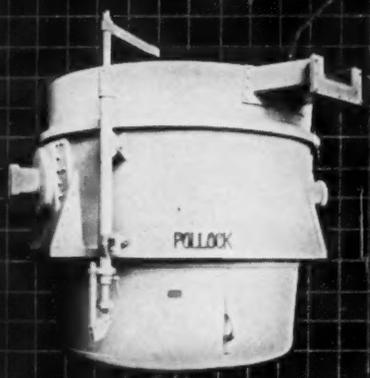
FRONT-FLUSH SLAG CAR

CHARGING BOX CAR



INGOT CAR

OPEN HEARTH LADLE



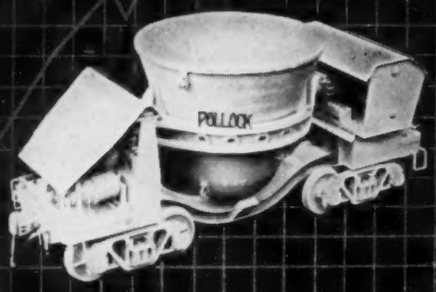
SLAG CAR

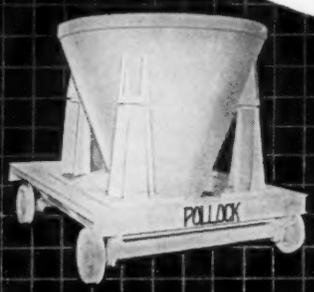
an important factor in increased open hearth production

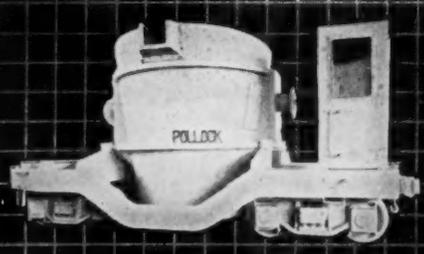
• Pollock experience in the development and construction of open hearth equipment assures smooth flow of operations. To measure use-value of Pollock handling equipment, add their day by day engineering research to 85 years of producing for the steel industry. General specifications available on request. Special-performance details engineered for your needs.

DRAG-OUT SLAG CAR

HOT METAL TRANSFER CAR



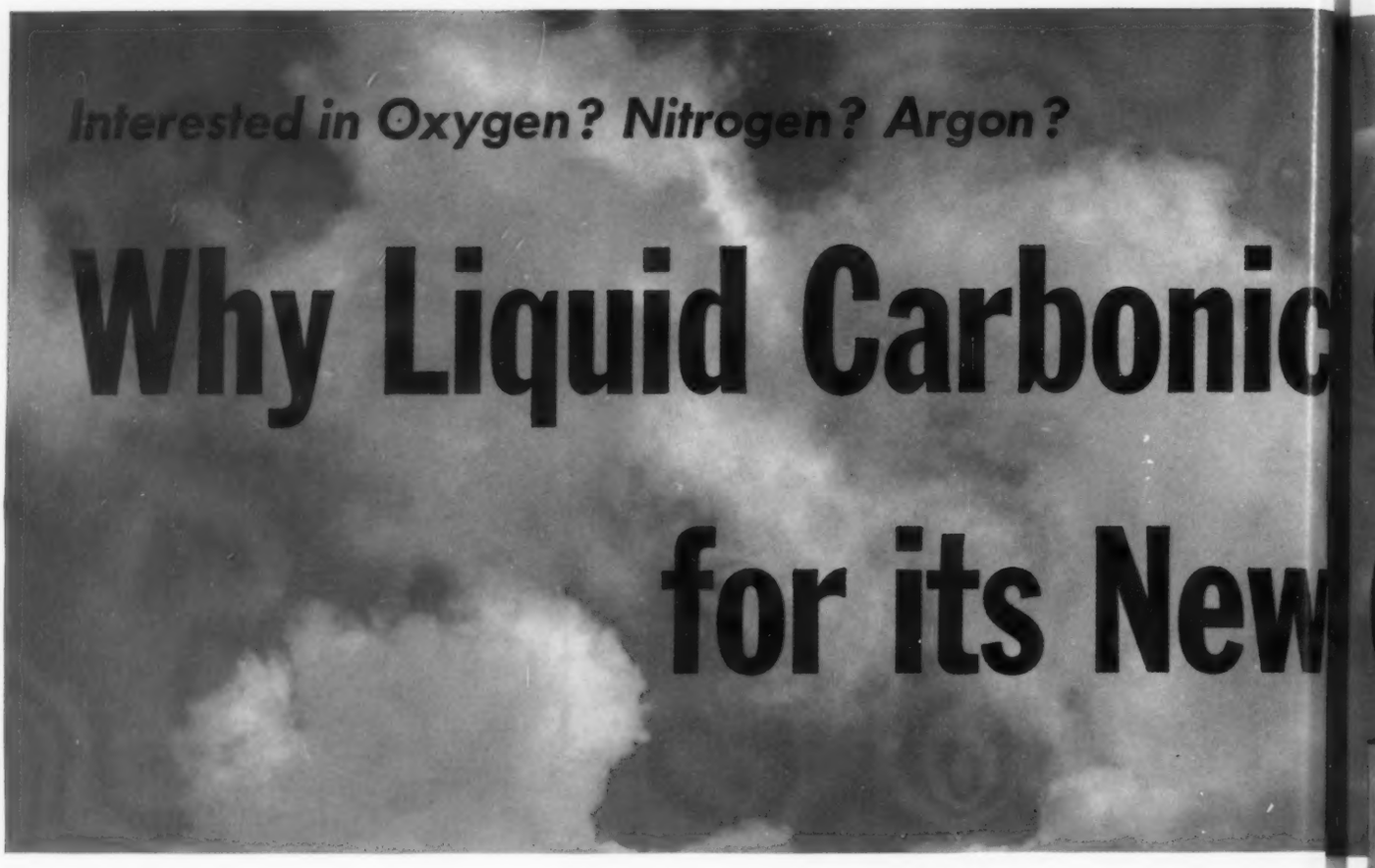




POLLOCK
SINCE 1863

THE WILLIAM B. POLLOCK COMPANY
YOUNGSTOWN · OHIO
STEEL PLATE CONSTRUCTION · ENGINEERS · FABRICATORS · ERECTORS

BLAST FURNACES · HOT METAL CARS AND LADLES · CINDER AND SLAG CARS · INGOT MOULD CARS · CHARGING BOX CARS · WELDED OPEN HEARTH LADLES



The Liquid Carbonic Division of General Dynamics doesn't take unnecessary chances. This prominent firm had confidence that they could rely on Messer to design and engineer a new air separation plant that would give more than just "satisfactory" results.

What Happened?

American Messer met the production schedule, and in February, this Liquid Carbonic plant at Urbana, Ohio went on stream. This tonnage plant is exceeding specifications—it can and does turn out liquid products at purities much higher than specified. The plant is also exceeding specifications in capacity and output.

Generous design margins and comprehensive automatic instrumentation give exceptional flexibility and completely stable operation at minimum operating cost.

You Can Depend on Messer

Messer-engineered plants have been operating with outstanding success in the U.S.A. since 1913 and for more than 50 years in many other countries. Where can *you* profitably use tonnage oxygen, nitrogen, or argon? If you decide to build your own plant, American Messer can assure you of best value for your investment dollar. Your inquiry will be welcomed.

Messer

AMERICAN MESSER CORPORATION

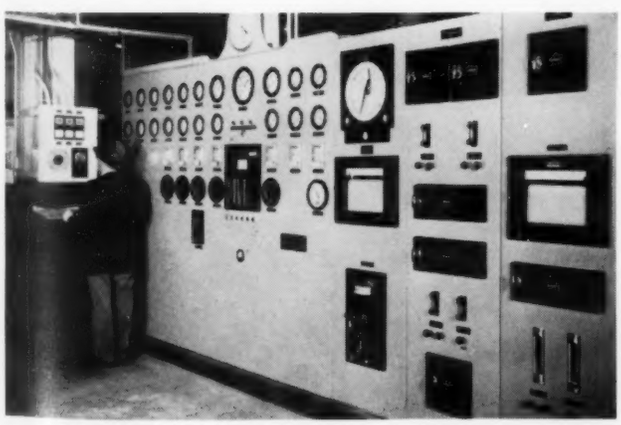
Chrysler Building • 405 Lexington Avenue • New York 17, N. Y.

"THERE IS NO SUBSTITUTE FOR MESSER EXPERIENCE"

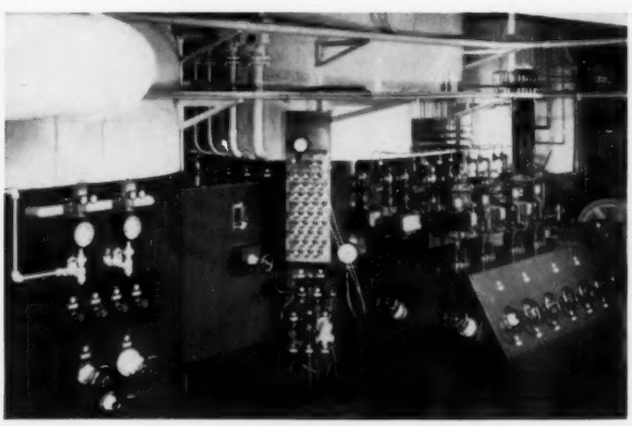
Chose MESSER

Oxygen Plant

HIGHLY EFFICIENT . . . View of the Urbana, Ohio plant showing the Messer fractionating column extending above the building.

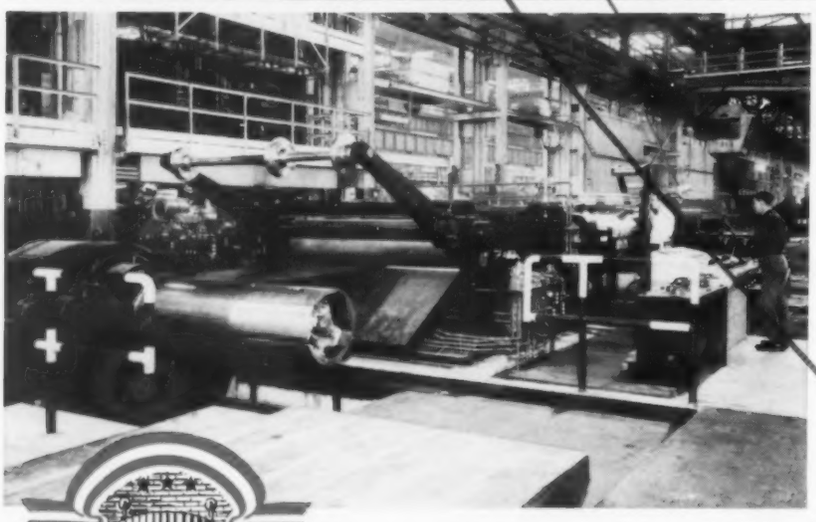


CONTROL PANEL indicating, recording, and controlling all important process variables shows the high degree of instrumentation typical of Messer plants.



CONVENIENCE—Careful piping design brings major valves to convenient, logical locations for ease of operation and maintenance. Test and sample connections are brought to a central control board.

One of the largest slitting & coiling lines



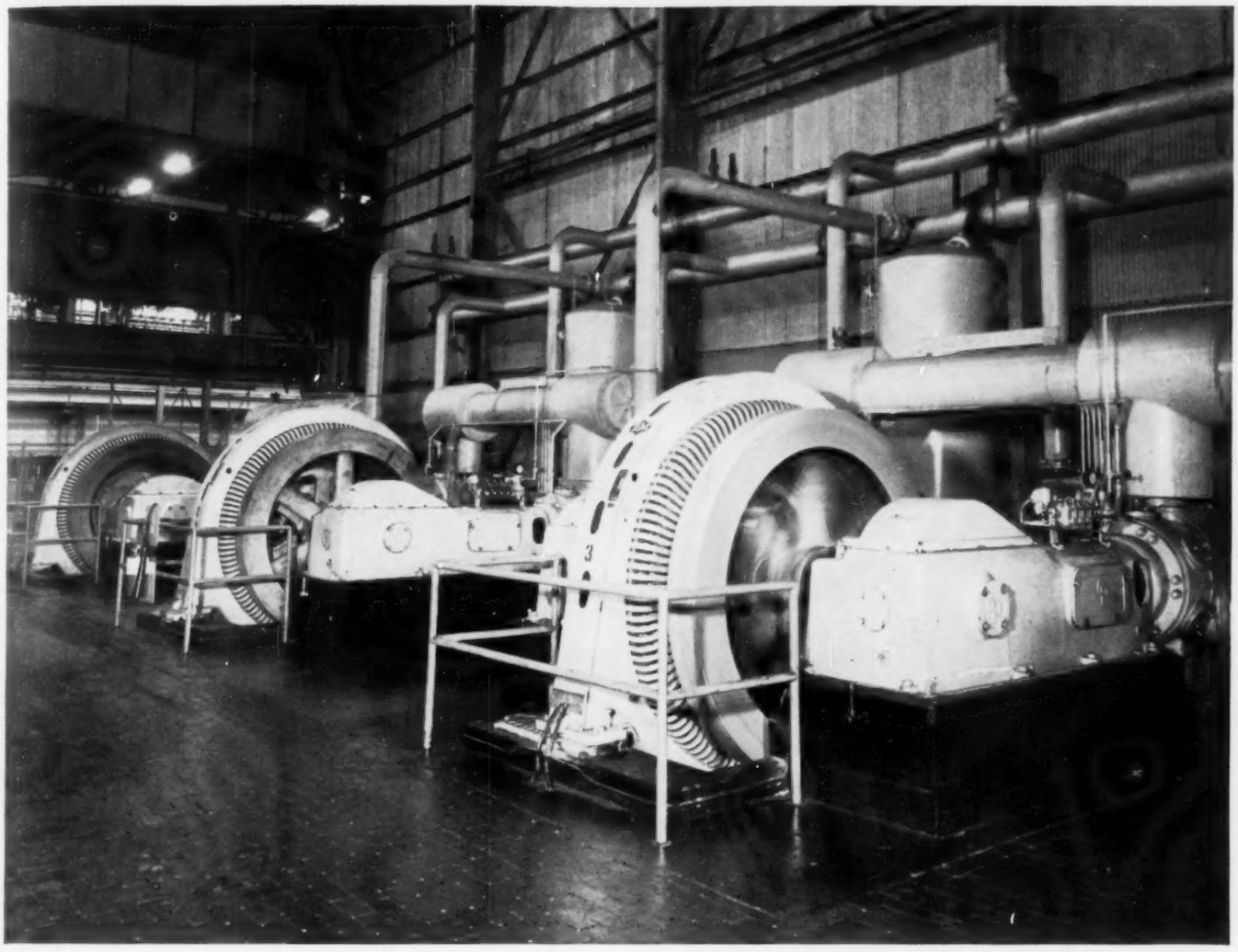
60,000 pound, 75 inch wide—Slitting and Coiling Line

Years of experience have given us the ability to furnish equipment to meet every slitting and coiling requirement. Bulletin SC55 gives our complete story. Ask for it on your letterhead. No obligation.

Photos show Stamco slitting and coiling unit in cold strip mill

ADVANCED ENGINEERING • SUPERIOR CRAFTSMANSHIP

STAMCO, Inc., New Bremen, Ohio



Above are three 500 hp, 225 rpm, 2300 volt, 0.8 power factor E-M Synchronous Motors driving air compressors in the tin finishing department at the new Fairless Works of United States Steel Corporation. Three other 500 hp and five 300 hp E-M Motors also drive air compressors, in the hot strip and slab mill, central power station, open hearth pumphouse and sulfate building of the coke works.

Power costs held low on compressor drives at new Fairless Works

Supplying air for controls, tools, handling systems and maintenance equipment is vital business at Fairless Works. And cost of power for operation of the air compressors is an item to be watched in such a large mill.

That's exactly where the E-M Synchronous Motors fit in. They help contribute real economy and rugged reliability to compressor operation.

First of all, these 11 E-M Motors are capable of supplying approximately 2700 reactive kva to improve plant power factor, a significant element when you want to minimize power costs.

Secondly, the inherent high efficiency of E-M Synchronous Motors utilizes power most sparingly.

Other economies are accomplished by use of simple and low-cost full-voltage control for across-the-line starting. Maintenance economy is foretold by simplicity of E-M Synchronous Motor direct-connection . . . by extra strong lashing of E-M stator coils . . . by the high capacity of E-M cage windings to withstand repeated starting stresses.

To get top performance from your large compressor drives, discuss your needs with your nearest E-M sales engineer. And write factory for E-M Synchronizer No. 42, a special issue on the ABC'S of Synchronous Motors.

ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

E-M

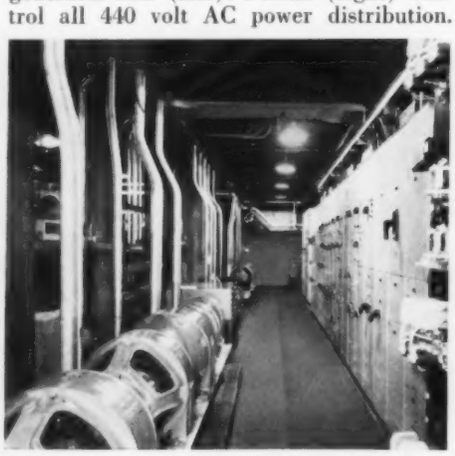
1200-TPA-2168A

Specialists in making motors do
EXACTLY WHAT YOU WANT THEM TO

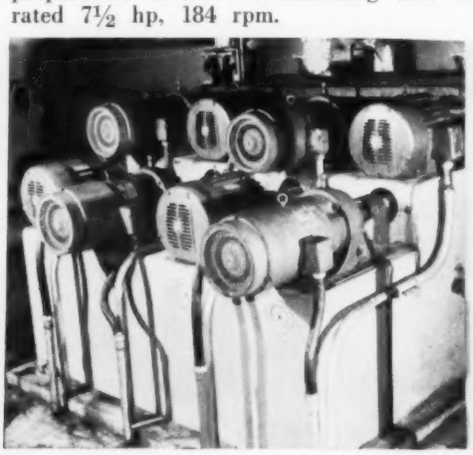
SPACE-SAVING General Electric continuous annealing line helps reduce annealing time, improves strip quality.

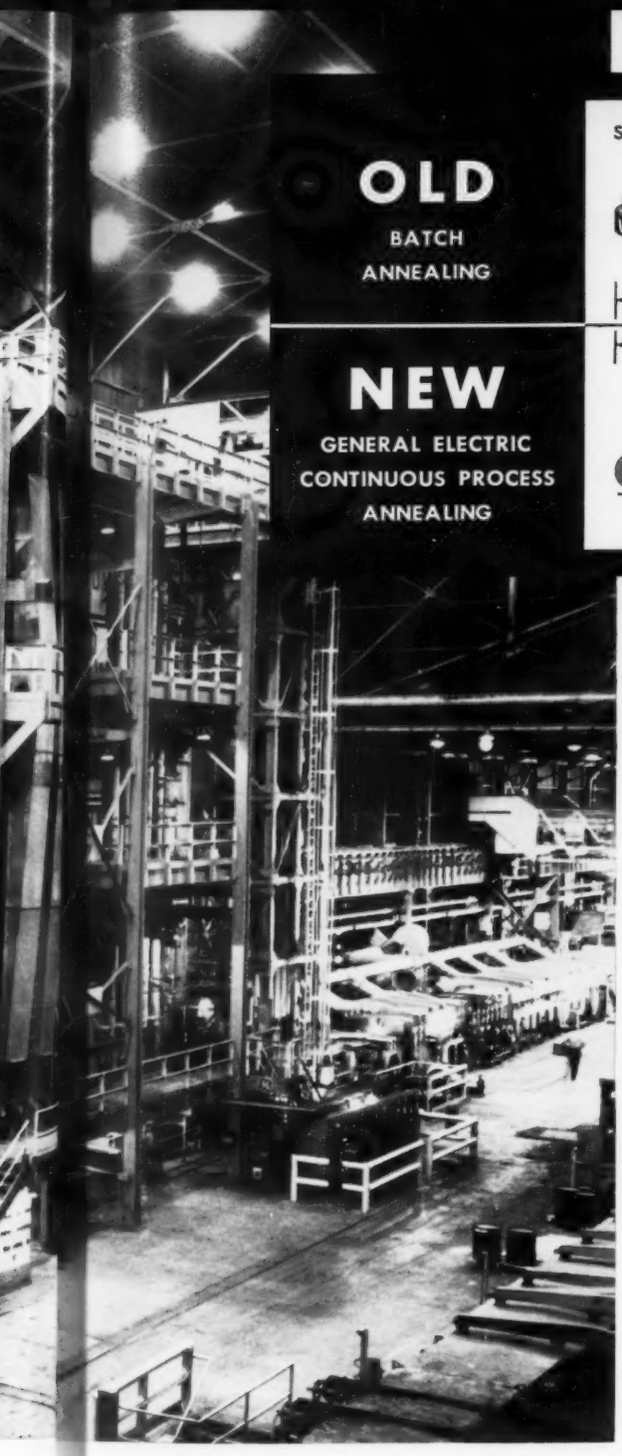
ACCURATE SYSTEM CONTROL is provided by this centralized, space-saving General Electric DC adjustable voltage control panel lineup.

ABUNDANT POWER for operating furnace rolls is supplied by these G-E motor-generator sets (left). Panels (right) control all 440 volt AC power distribution.



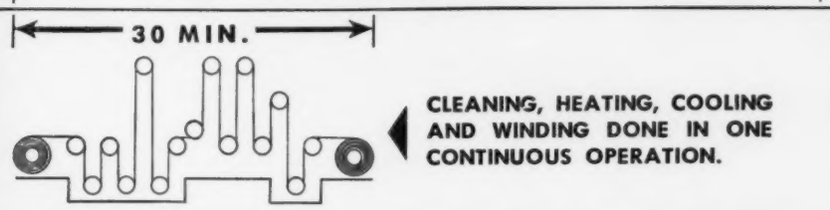
POWER-PACKED lineup of new General Electric gear-motors used on cleaning and preparation section of annealing line are rated 7½ hp, 184 rpm.





OLD
BATCH
ANNEALING

NEW
GENERAL ELECTRIC
CONTINUOUS PROCESS
ANNEALING



GENERAL ELECTRIC HELPS
YOUNGSTOWN SHEET & TUBE

Reduce Annealing Time from 5 days to 30 minutes

A new G-E continuous process annealing line recently installed at Youngstown Sheet and Tube's Indiana Harbor tin mill, East Chicago, Ind., has demonstrated its economy and efficiency in only a few weeks of "on-the-line" operation.

According to Youngstown engineers, "The line not only increases productive capacity, but does it in about a third less space, and a lot faster —too." Generally, the line has improved operation efficiency by as much as 100 per cent, and cut annealing time from 5 days to 30 minutes over one of the batch annealing installations previously used.

Here's how G-E continuous annealing benefited Youngstown:

1. Greater uniformity with continuous anneal—every part of coil is exposed to the same annealing conditions.

2. Higher temperatures uniformly and easily obtained—permit considerable savings because equivalent strength and stiffness can be obtained with thinner gage steel.

3. Superior resistance to corrosion of the base metal is obtained—results in some lengthening of the average shelf life of canned products.

4. Time is saved—continuous process reduces material handling.

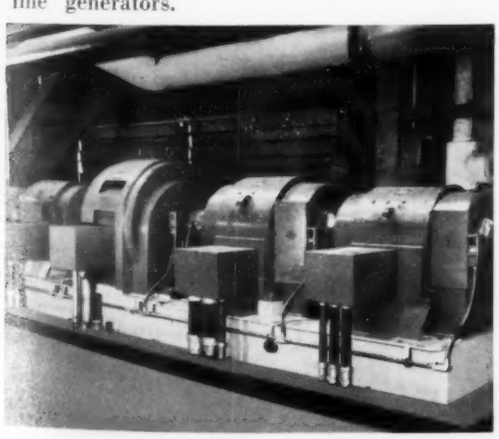
5. Space saving—floor space is reduced by at least a third.

In addition, G-E continuous process annealing lines contain the latest developments from G-E product and research laboratories. Such product progress, as indicated by newly applied G-E D-C Kinamatic* gear-motors on Youngstown's annealing line, is immediately passed on to improve complete systems.

Get complete information on how electrical systems for continuous annealing line can benefit your operation from your nearest G-E Apparatus Sales Office. Ask for bulletin GEA-6017A, Electrical Systems for Continuous Metal Processing. General Electric Co., Section 659-124, Schenectady, N. Y.

** Reg. trade-mark of General Electric Co.*

MASTER MOTOR-GENERATOR set with General Electric motor rated at 700 hp, 1200 rpm, 2300 volts, drives four G-E annealing line generators.

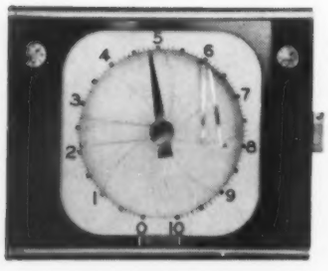


Engineered Electrical Systems for the Steel Mill Industry

GENERAL ELECTRIC

Bristol's 7-point coast-to-coast field service

Helps you from the time you start thinking instruments – through installation – for as long as the job requires



A Bristol Field Engineer is the man to call when you first start thinking about instrumentation. Located in a nearby Bristol office (they blanket the U.S. and Canada) he calls at your plant to assist you in planning your proposed installation. No obligation.

Application Engineers, specialists in the abilities and limitations of every type of instrument, and Process Specialists, experts in instrumentation techniques in varied fields can be called in where necessary. They insure you the right instrument, installation and operation for your specific job.

Service Engineers to keep your instruments operating perfectly are "on call" often within a few hours. They install, check and adjust instruments in your plant.

Periodic Check-up Service at regular intervals is also available.

Bristol's Instrumentation Schools for customer engineers help train your own technicians in instrument operation and maintenance.

Factory Repair Service at San Francisco, Los Angeles, Chicago, Houston, Waterbury and Toronto has all facilities, parts, experience to properly repair, recondition and remodel Bristol instruments. Each instrument reconditioned carries a new instrument warranty.

Fast Parts Service is assured by the Bristol practice of stocking service parts that may be needed in emergencies in all 38 Branch offices. You get fast action from a near-by source.

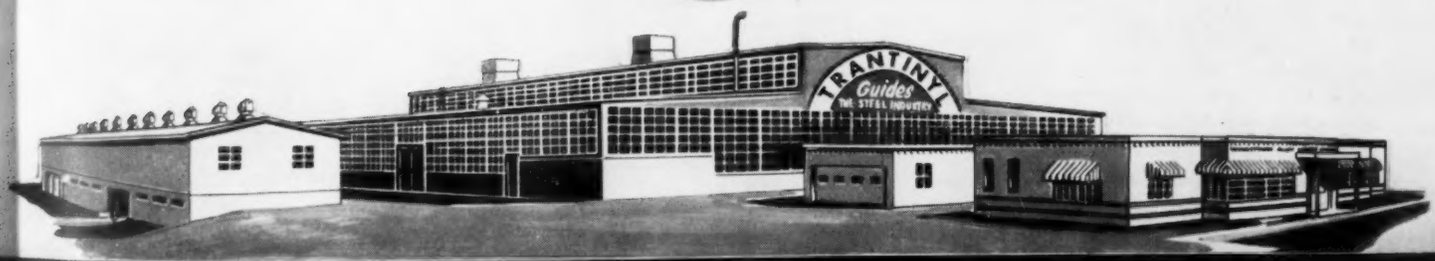
These big extras you get with Bristol instruments are good reasons—over and above outstanding basic instrument quality—why every Bristol installation gives such high accuracy and precision performance over an extremely long service life. To find out more about Bristol instruments or service, write: The Bristol Company, 123 Bristol Road, Waterbury 20, Conn. 8.17

BRISTOL TRAIL-BLAZERS IN PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

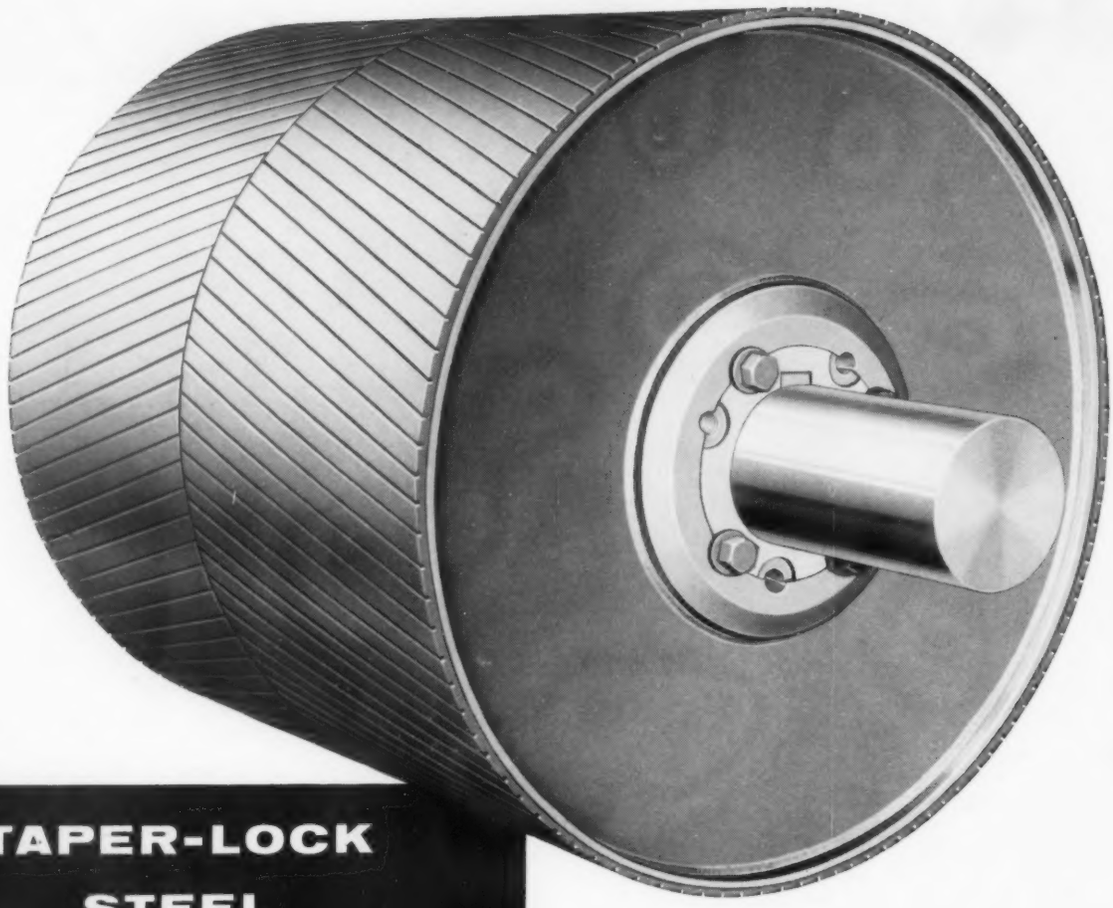
TRANTINYL

guides the steel industry



YOUNGSTOWN ALLOY CASTING CORP., • YOUNGSTOWN, O.

ROLLING MILLS: bar, hoop, strip, shape mill guides, and rollers. SEAMLESS TUBE MILLS: guide shoes, rolling mill plugs and rolls, piercer points, etc.
ELECTRIC WELD TUBE MILL: forming rolls, planishing rolls, tool holders, etc. • STRAIGHTENING MACHINE GUIDES • HEAT RESISTING CASTINGS



TAPER-LOCK STEEL CONVEYOR PULLEYS

Maximum strength with minimum weight...

Unmatched holding power on the shaft...

New mounting simplicity.

The rims, discs and hubs of these modern conveyor pulleys are *steel*—and they are fused together into jointless drum construction for (1) maximum strength with minimum weight, (2) exclusion of dirt, water, steam, (3) terrific shock resistance.

With the patented Dodge Back-up Bar, welds of full rim thickness are achieved—and the ultimate in strength is assured by submerged arc process welds.

Taper-Lock Steel Conveyor Pulleys *hold*. Taper-Lock provides the equivalent of a shrunk-on fit—there is no "walking" on the shaft. Mounting and demounting are simple. Pulley and bushings mount as a unit. Alignment is easy. And the tapered bushing is wedged into place merely by turning the mounting screws. It is "unlocked" by using the mounting screws as jack screws.

Available in diameters from 6 inches to 8 feet—all face widths. Standard or special rubber lagging available. Ask your local Dodge Distributor—or write us for bulletin.

DODGE MANUFACTURING CORPORATION, 5900 Union, Mishawaka, Ind.

97 Taper-Lock Steel Conveyor Pulleys are used in this famous conveyor system engineered, manufactured and erected by Hewitt-Robins, Inc., at the Southern Pacific's causeway construction across the Great Salt Lake.

DODGE

of Mishawaka, Ind.

CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

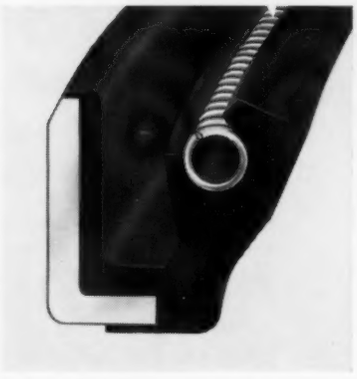
ANOTHER OF THE GARLOCK 2,000

LET 'EM ROLL...

fully protected by Garlock KLOZURE* Oil Seals

Each mammoth roll of a rolling mill is precisely designed and balanced. KLOZURE oil seals help maintain that balance through maximum bearing protection.

GARLOCK KLOZURE 142A—designed primarily for steel mills to seal surfaces perpendicular to shaft such as at end of mill roll. Acts as initial seal, keeps excessive water, scale, and other foreign matter from bearing oil seals. Available in any length for any diameter over 12″. Comes in straight strip with strap for fastening. Maximum surface speed 5000 fpm, temp. 250° F. constant.



GARLOCK KLOZURE 2782—Positive oil seal protection for steel mill bearings. Garter spring holds Buna-N sealing element in contact with shaft. Precision formed case molded to sealing element protects seal from damage, and provides a press fit for proper installation. Available normal to high speed use on shafts to 48″ dia., temperatures to 250° F, and for applications involving low pressure differentials.

It's easier to find the KLOZURE Oil Seal for your job because Garlock has one of the largest stocks available. Moreover, for any sealing problem, you can choose from the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals. The only complete line. Call your Garlock representative or write for KLOZURE Catalog 20.

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THE GARLOCK PACKING COMPANY, Palmyra, New York

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U. S. and Canada

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

How to get greater yield at your present production rate

V-TOP PALLET CONVEYOR transports huge coils from coiler to storage in this hot strip mill. Link-Belt's two other basic coil conveyor types are shown below.

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With Link-Belt coil conveyors, movement of coils is controlled . . . there's no telescoping . . . no scuffing of edges. These rugged but gentle conveyors move coils up to 75,000 lbs. They travel smoothly around corners, up and down inclines . . . and they promote safety by eliminating the need for vehicles and limiting the use of overhead cranes.

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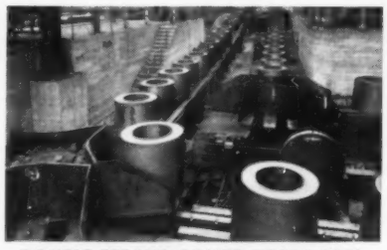

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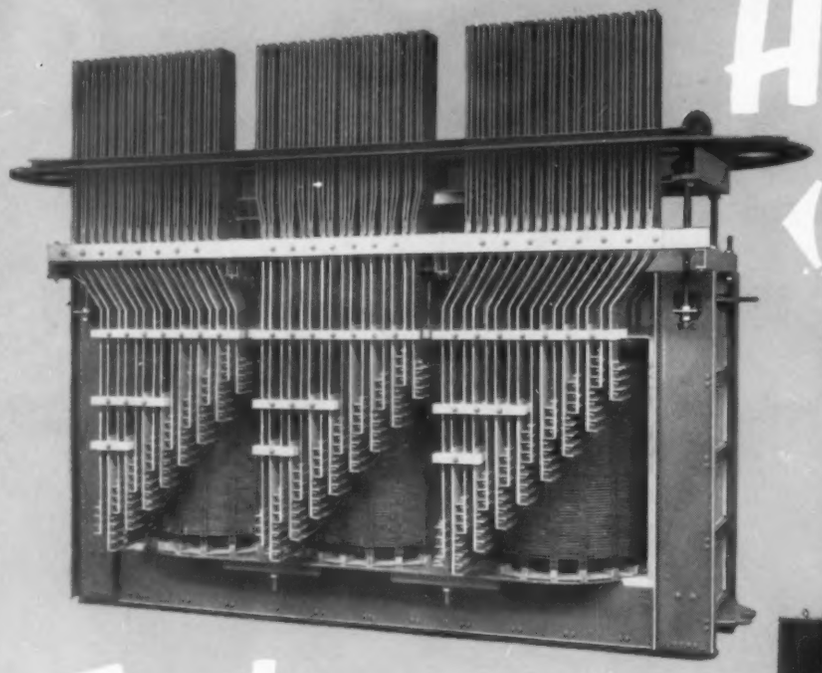

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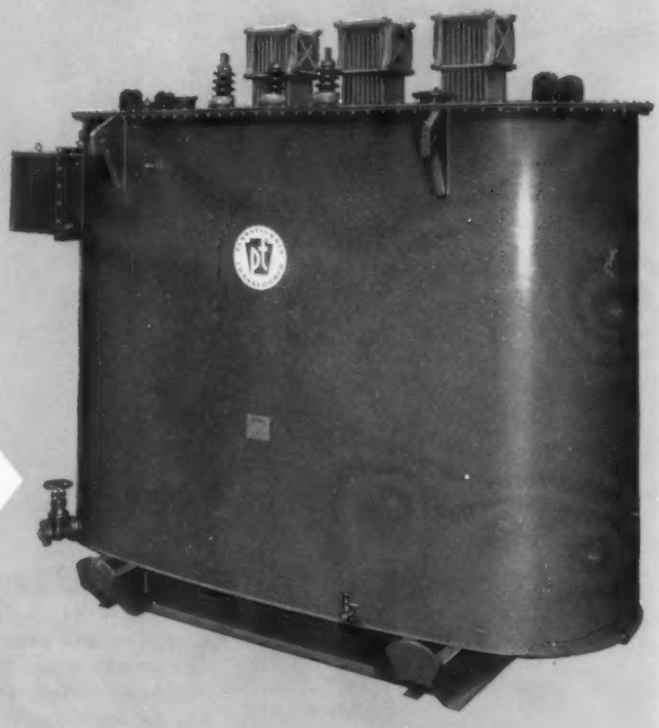

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MECHANICAL MANIPULATION IN BAR MILLS

Figure 1—With this tilting table, billets up to 800 lb can be rolled in this reversing, three-high roughing stand by two rollers and a hooker.

by E. C. Peterson, Vice President,
Rolling Mill Equipment Div., Birdsboro Steel Foundry and Machine Co., Birdsboro, Pa.

THIS paper examines some of the mechanical devices available for handling pieces through the guides and passes of bar mills. Some material that has been presented in previous papers is reviewed here for the sake of completeness.

The roughing mill is discussed first. In the classic Belgian mill the roughing stand is 3-high. From three to nine passes are usually taken. In hand mills this manipulation is handled by the rougher on the down side and the hooker and rougher on the up side. This hooking up operation is suitable for billets of 500 lb or less. Two hookers can handle 800 lb, and with a mechanical hoist 1200 lb can be lifted. The operation is very fast. There is probably no mechanical arrangement that can keep up with it, but it requires a crew of at least three men. As the size of billet increases, extra men must be added; and the work becomes arduous and slow. Five hundred pounds probably represents the maximum practical billet load for such an operation. The growth of billet weights and pressure for elimination of the more arduous manual operations have led to various degrees of mechanization in roughing mills.

The first such step is the simple tilting table. On such a table as shown in Figure 1 the bar is lifted on the high side while being turned up and guided into the next pass by the rougher. With small billets, one man on each side of the mill and an operator in the pulpit will work the mill. If the billet is over approximately 280 lb in weight, however, it will probably be necessary to put the hooker back into the crew to assist the rougher in moving the front end of the piece from pass to pass. In such a case the crew has actually been increased by one man over the unmechanized roughing stand, but billets of 800 lb can be handled easily.

In order to dispose of the hooker entirely and to speed up the operation on the tilting table, various types of movable sideguards are added to tilting tables. In one design, seven passes are taken on the stand, and three sideguards are provided. Each of these sideguards is individually adjustable as to stroke and position and derives its motion from the movement of the tilting table. Some of the flexibility of the hand mill is sacrificed, but the device is relatively inexpensive, is rapid in operation, and permits the rolling of more than one piece in the mill at a time.

The advantages of this type of sideguard can be retained, and more flexibility can be maintained by substituting hydraulic actuation and using one of the numerous systems of remote positioning control now available. With such an arrangement the position and stroke can be readily set at any time by the operator, and can be arranged to work automatically as the table lifts in the same manner as the mechanical unit.

If flexibility of operation is of paramount importance, motor-driven sideguards, controlled by an operator in the pulpit, can be used. As the rougher turns up the bar, the operator moves it from pass to pass with one of the movable sideguards. If necessary he can move it back or straighten it by using the other sideguard also. Three men, including the pulpit man, are required to operate the stand. Production is limited because only one bar can be rolled at a time. Also the manual operation of this type of sideguard is slower than an automatic operation.

When pieces of over 600 lb are to be handled, it becomes desirable to have tilting tables on both sides

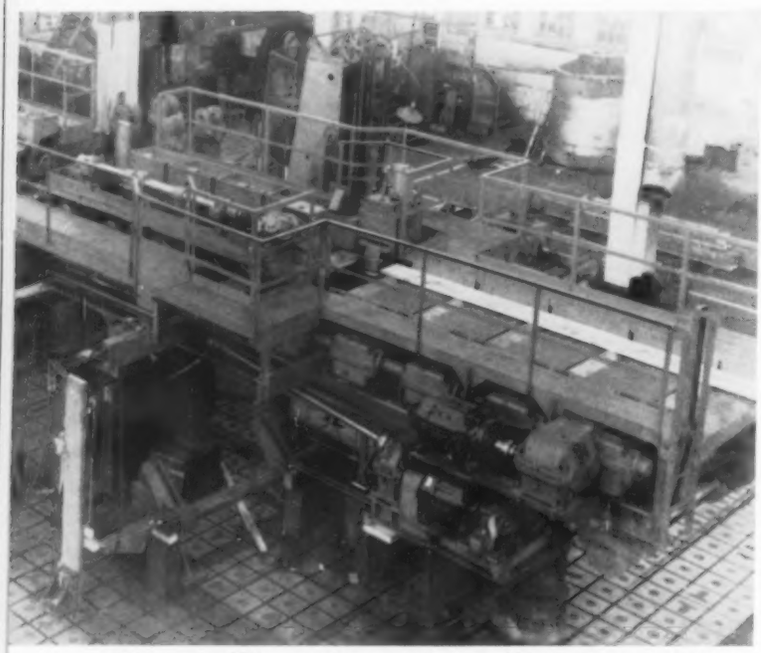


Figure 2—When billets weigh over 600 lb, it is desirable to have tilting tables on both sides of the roughing mill and to provide these tables with movable sideguards and turnup devices.

of the mill and to provide these tables with movable sideguards and turnup devices, as shown in Figure 2 while on the assembly floor. This mill has a pulpit operator on each side, but no men are required on the mill tables. One operator could be used if the sideguard drives were mechanically connected. This can be done but with some complication. A finger lift is provided for turning work pieces into box passes, and an auxiliary turnup is shown on the end of the sideguard for working diamonds and squares. At this point the 3-high rougher has been completely mechanized but at considerable cost. However, manual labor is eliminated and there are no limitations on the weight of the work piece.

A special type of mechanization is used with 3-high roughers in the nonferrous field in which the product is rolled on a fixed set of reductions, which are never varied, and where the groove wear is slight. Such a unit has lift troughs for the high side and falling tables for the down side. The bars are turned 90 degrees when falling by the shape of the skids and by a turning gear on one of the lift tables. Rams enter the bars into the mill, and all operations are powered with compressed air. A system of photocells and interlocks operates the entire unit automatically. Seven passes are given in 21-in. rolls to a 4-in. square, 160-lb aluminum billet at a mill speed of 570 fpm. Four pieces can be roughed at once, and the unit has operated at rates up to 168 billets per hr. Duplicate grooves of passes four through seven can be served.

The 3-high mill can be completely mechanized as described above, and it can even be provided with top and bottom motor operated screw adjustment to gain flexibility in passes and reduce roll changing. At this point, however, it sometimes becomes expedient to substitute the 2-high reversing rougher, similarly equipped with moving sideguards, finger lift and auxiliary turnup. This unit is operated by one man. The auxiliary manipulator as shown in Figure 3, is turning up an oval for entry into a square pass. Most of these auxiliary units are operated merely by bringing them into operating position with an air cylinder, and then bringing the sideguards together. For some sections, such as blunt octagon ovals, it is necessary to provide extra actuation of one of the rollers to secure proper turning action. In all units when the air is withdrawn from the cylinders, the roller units remain in retracted position out of the way of the work piece.

For purposes of cost comparison we may consider an 18-in. roughing mill which is to handle billets up to 600 lb. Considering the cost of a simple single stand mill with a-c motor and plain tables without mechanical devices as unity, the following comparative costs may be noted:

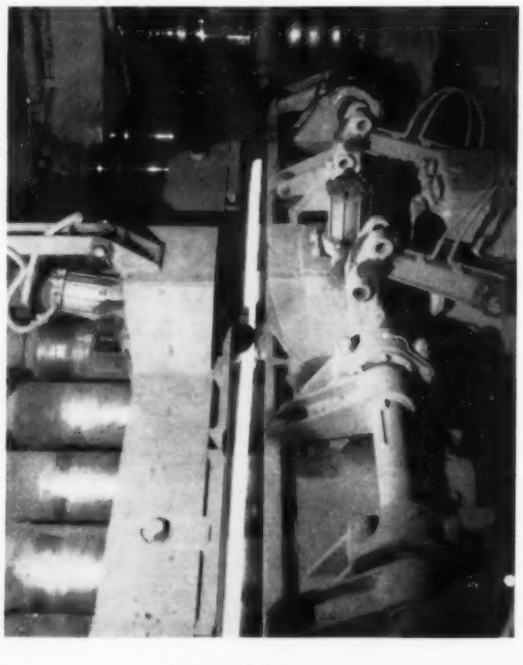
1. Mill with simple tilt table on the up side and flat table on down side, approximately 1.1.
2. Mill with tilting table with automatic mechanical dragover on up side and flat table on down side, approximately 1.15.
3. Similar mill but with automatic hydraulically-positioned dragover, approximately 1.25.
4. Similar mill but with electrically-driven and manually-controlled sideguards, 1.3.

If the cost of a 24-in. 3-high mill complete with two tilting tables, adjustable sideguards, finger lift and auxiliary turnups, and non-reversing a-c motor is set at unity, a 20-in. 2-high reversing mill with similar equipment, except for a reversing d-c motor and motor-operated screwdown, has a cost of approximately 1.7.

Two kinds of manipulation are used in finishing mills: straight work in which the bar runs straight away from each pass and reverses direction to enter the next pass, and looping, in which the leading end of the bar is looped around and entered into the succeeding pass.

In handling straight work, two problems must be considered. One is transferring the bar from pass to pass, and one is turning the bar up before entry into the next pass. In hand mills the bar runs out on the mill

Figure 3—This auxiliary manipulator is turning up an oval for entry into a square pass.



standing, which usually consists of iron plates, and is dragged from stand to stand by tongsmen. The length of piece that can be handled in this manner is limited by the ability of the piece to push itself out against the friction of the floor plates without buckling and tangling. With heavy bars, a hook suspended from an overhead rail is required, and a hooker transfers the front end of the piece while tongsmen assist in dragging the rest of the piece across on the floor plates. The weight of piece that can be handled in this manner is, of course, limited; and the operating cost is high.

Modern bar mills often have all finishing mill stands 2-high. This means that the bar must be transferred from stand to stand between each pass. The mill stands are placed in staggered arrangement to permit individual drive of each stand. Some form of table and transfer is required to pass the bar from delivery to entry of the next pass. The usual arrangement, and in many ways the most satisfactory, consists of a straight runout table and a straight entry table connected by suitable flooring and provided with a chain transfer. These chains can have fixed dogs, in which case the transfer must be stopped at an appropriate position by the operator in order to deliver the bar into the mill at the right point; or the chains may be provided with disappearing dogs, in which case the dog is set to drop out of active position at a predetermined point, with the transfer itself running automatically each time and stopping always at the same point by limit switch. An additional safety feature is inherent in this disappearing dog type of chain in that there is no danger of an operator getting his foot caught between the dog and the table sideguard as the dog passes through it.

There are occasions where the conventional chain transfer, with its drive and idler sprocket and chain running endlessly around them, cannot be used. One of these is when surrounding conditions make it impossible to install the idler sprockets. A case in point is a mill where overlapping of the looping floors and tables between the intermediate and finishing mills made it necessary to place the runout table at an angle and eliminate idler sprockets. In cases like this, roller chains with pusher or puller dogs can be used quite effectively. The chain running over the drive sprocket can either loop down into a pit or run back under the table in return guides when space is available.

In order to reduce the cost of the straight runout and runin table with cross transfer, the skew table has been used for many years.

Such a table is shown in Figure 4. Here a single table accomplishes the purposes of runout, transfer and runin. This table has two principal disadvantages. First, in order to accomplish transfer it is necessary to run the bar some distance from the roll stand in order to permit the skew angle of the rollers to move the piece across the table during approach to the succeeding roll stand. This extra travel loses time in the mill. Second, when a bar of blunt cross section, such as a lead oval, is completely transferred and is running against the sideguard of the table during final approach, the skew angle of the rollers causes the piece to roll about its longitudinal axis. Most modern bar mills include bar turners and entry into the turner is made difficult by this rolling action. This rolling action also causes the table rolls to wear out rapidly at the approach sideguard.

While considering Figure 4, it is convenient to mention the cross-country arrangement of roll stands and transfer tables. In the Figure the skew table in the foreground serves a 12-in. leader and finishing stand. To the left of the leader stand can be seen a 14-in. intermediate mill; and between the 14-in. stand and the 12-in. leader can be seen, in the background, two more 12-in. stands in cross-country arrangement. In such an arrangement the bar travels through two or more passes in the same direction and are taken from stand to stand by straight tables. Periodically the direction of rolling is reversed by use of transfer tables as described above. Such an arrangement is often used where space permits. It is open to criticism in that the space between stands in such a straight run must be made somewhat greater than the longest work piece to be handled. If short billets are required because of difficulty in rolling a particular section, and if good rolling temperature must be preserved; the long run between stands is a handicap. Further, if the pieces are subject to splitting at the ends, a succession of passes in the same direction will aggravate the condition. Both of these objections would be more significant when rolling high alloy steel than they would be when rolling carbon steel.

A second and recent design of the transfer table that approaches the economy of the skew table and still overcomes the objections to the latter is shown in Figure 5. This is a Y-shaped table with a sweep-arm transfer at the front end. The leading end of the work

Figure 4—In order to reduce the installed cost of the straight runout and runin with cross transfer, the skew table shown here was developed. However, this table slows down the mill and causes excessive wear on that part of the table rolls near the approach sideguard.

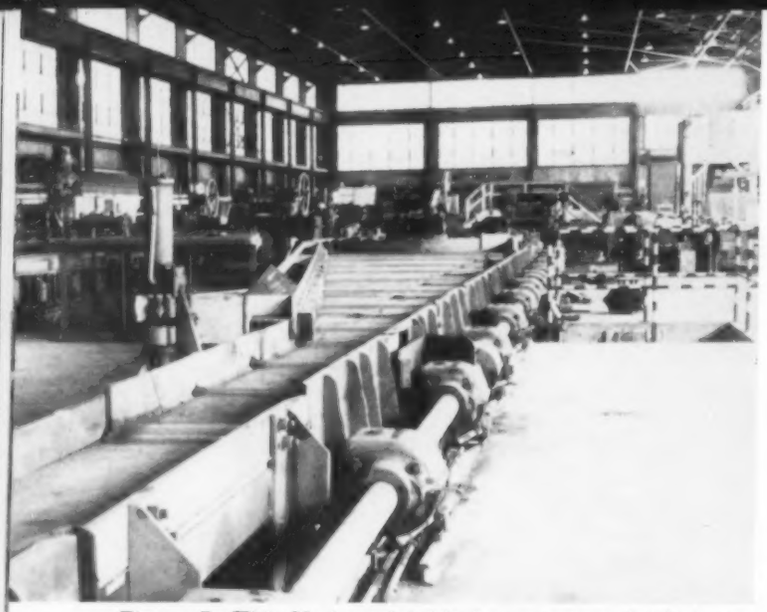


Figure 5—This Y-shaped table is a compromise between the installation economy of the skew table and the functional desirability of chain transfer. However, it cannot handle wide flats or heavy sections.

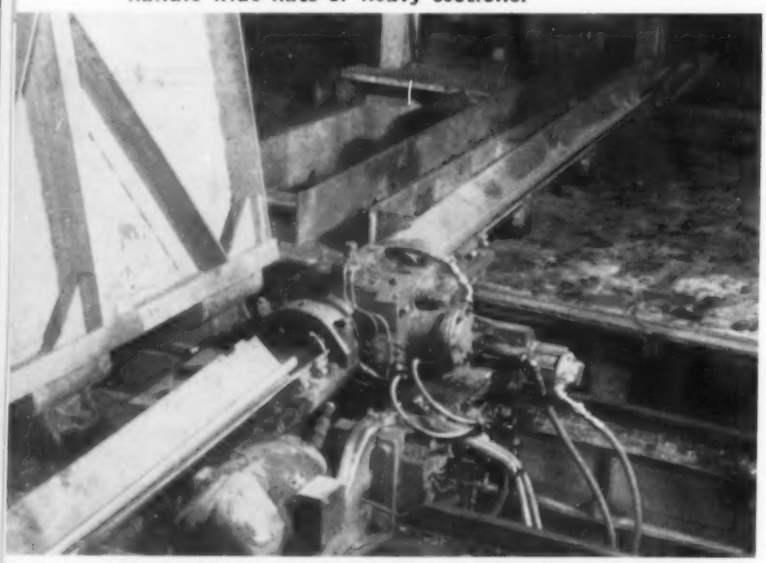


Figure 6—Shown here are a trough and transfer which together form an economical unit for runout, transfer and delivery on a bar mill.

Figure 7—This three-high rougher, previously hand operated, was mechanized into a tandem roughing arrangement by the use of lift arms and a skid bar for transfer of bars from its upper to its lower pass line.

piece, as it is delivered from the preceding stand, is guided by the angularity of the sweep arm to a runout table in line with the next stand. After the bar is dropped out of the mill, the sweep arm transfers the back end to a position in line with the next stand. Then the table is reversed, and the piece is fed into the next pass. This transfer table is simple to build and avoids the objections to the skew table mentioned above. Both types are limited to the width of flats and the weight of sections that can be fed onto them satisfactorily.

With the sweep arm transfer it is necessary to have sufficient space between the bars to permit the return of the sweep arm to its open position. Because this period is usually less than that required to clear the succeeding pass, no delay in mill operation is involved. On both the skew table and the Y-table with sweep arm transfer, often a piece will be fed out onto the table while the preceding piece is still going through the next pass. In order to deliver the second bar satisfactorily it is necessary to run the rolls away from the mill against the entering piece. This does not seem to cause any difficulty.

An economical unit for runout, transfer and delivery to a succeeding pass is shown in Figure 6. This unit has no table at all. The piece is handled, instead, in a long trough which has an angle cross section with apex down and small live rollers mounted at intervals. This trough is pivoted at a point suitably far away from the mill stands, and at its front end joins with a bar turning transfer. This transfer contains air-loaded pinch rolls, which are power driven. The entire pinch roll unit can be rotated about its axis and also moved from stand to stand as required. When the work piece is about to leave the preceding pass, the pinch rolls are actuated and used to draw the piece out of the guides and delivery trough. When this is accomplished, the transfer positions itself in front of the succeeding pass. The pinch roll unit rotates through 90 degrees if necessary during the transfer operation. The pinch rolls themselves are then driven in reverse direction to drive the piece into the succeeding pass. When repeating is to be done on the mill shown, the bar turning transfer is run to the right out of line of both stands; and the apron, which is shown in vertical position at the left, is dropped into position completing the looping floor for the repeater, which is always left in place. This unit is very satisfactory in certain applications, but it is limited in production ability by the fact that it cannot return to pick up another work piece until the previous piece has completely entered the succeeding pass. This limitation is not serious in a mill where a multi-pass rougher limits production anyway.

Modern mechanized bar mills do not generally use 3-high stands. preferably they use 2-high stands all working on the same pass line elevation. An interesting exception is a very ingenious mechanization program, carried out on an existing bar mill at Milton, Pa., in which a tandem roughing arrangement was substituted for a 3-high hand-operated rougher. The piece runs five passes straightaway, and then changes from top to bottom and reverses direction as shown in Figure 7. At this point the bar is delivered between the middle and top rolls, moved on to skid bars by a lift arm,

slid to the approach table by gravity, and fed back toward the mill by an approach table. Before entering the mill again, however, it is stopped by a crop gage, which at the same time actuates the hydraulic crop shear shown. After cropping, the gage withdraws; and the bar feeds directly into the next pass. While this particular arrangement made good use of existing equipment and space, the mechanization of 3-high mills is usually difficult and not rewarding.

Figure 8 shows another type of 3-high mill mechanization in which one or three passes can be taken. Two bar turners are seen ahead of the mill for turning up ovals on the flat table. A tilting table and movable sideguard lift and transfer the bar on the back side. It is desirable to avoid turning on the tilting table if possible.

In order to give some idea of the relative cost of manipulating devices, let the cost of a standard runout table, chain transfer and straight runin table be unity. Approximate comparable costs would be: transfer with disappearing dog, 1.1; transfer with pusher chain and fixed dog, 1.0; skew table, 0.6; straight table for cross-country application, 0.4; Y-table with sweep arm transfer, 0.7; bar-turning transfer, 0.3; transfer skids and tables for three high mill, 0.8.

The problem of handling pieces in a continuous bar mill is relatively simple because the stands are quite close together, and each stand feeds the piece to the succeeding stand over a relatively short distance. It is desirable to operate with a slack loop between the stands to avoid stretching the work piece. Therefore the conveying table must incorporate means for leading the front end of the work piece directly to the next stand and, at the same time, provide space for a loop to grow in the piece once it is entered in the succeeding stand. An air-actuated roller on a swinging arm is called a "persuader roll." It is normally operated by the mill operator from the pulpit when the bar enters the next stand. It holds the loop out on the table and minimizes the natural tendency of the piece to make a sharp loop against the far side of the looping table with the danger of doubling into a hairpin hook. A replaceable bellmouth at the far end of the looping table helps to guide the oval to the mill guides. When flats are rolled, the loops must be dropped because flats will not bend sideways. Next to the side-looping table is mounted a separate trough with a drop bottom also air-actuated. The entire table assembly can be moved hydraulically to place either the side-looping or drop-looping trough in position, or it can be retracted out of the way entirely to permit access to the guides.

With such a looping table it is desirable for the pulpit operator to be able to look directly down into the troughs. If circumstances dictate that the operating pulpit be fairly off to one side, the operator will not be able to see down into the trough well enough to maintain good speed control. In order to improve visibility the table shown in Figure 9 can be used. This table is composed of individual rollers to minimize surface scratching, and the elongated body of the rollers provides a looping table. Space between the rollers gives the mill operator good visibility.

In the rolling of most bar mill products the work piece must be rotated about its axis between passes. With oval and square reductions the oval must be turned up on one end for entry to the succeeding square. The square will enter into the oval pass either lying flat on the table rolls or, in the case of continuous mills and repeating, twisting itself flat. In the diamond and square method of reduction the square must be held up on one corner for entry into the diamond. This requires a 45 degree turn from a flat position on a table roll or no turn at all in a continuous mill. The diamonds must be turned 90 degrees and held up on sharp corners for entry into the square pass. When flats and angles are rolled in open mills, the work piece must be turned up for edging passes two or three times in the finishing mills.

Turning devices can be divided into two classes: stationary and actuated devices. Stationary devices are of great variety and are usually developed and perfected by ingenious mill operators. The most common one is the "flipper guide" which is an entry guide so shaped that the entering piece engages deflecting surfaces that force it to turn into proper position as it progresses into the guide. This device is particularly effective on open tandem mill arrangements where the piece has

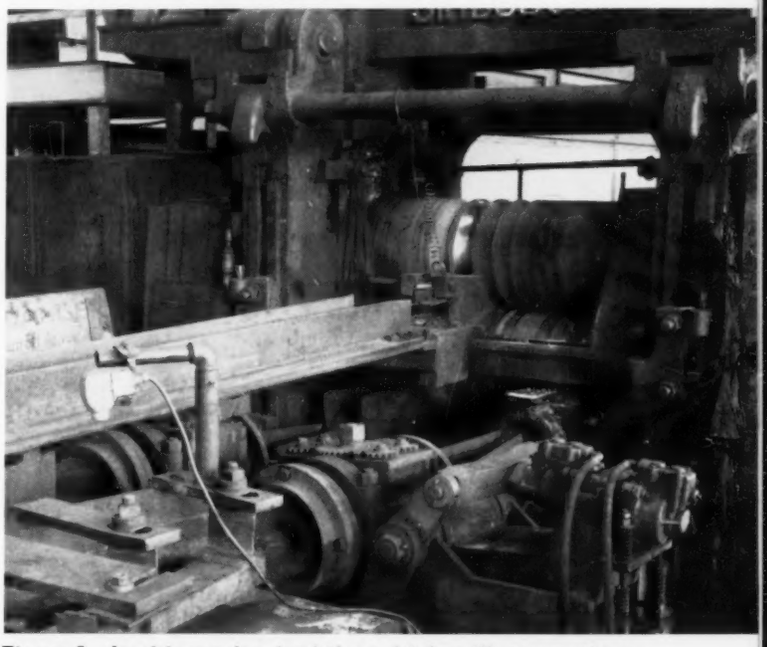
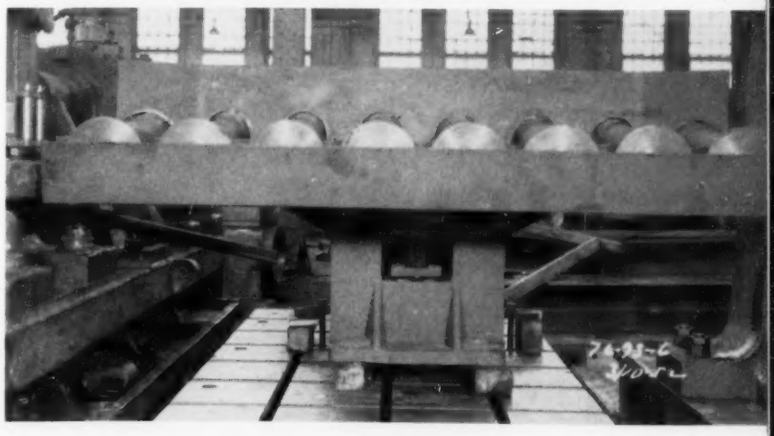


Figure 8—In this mechanized three-high mill, one or three passes can be taken. Two bar turners, seen ahead of the mill, are for turning up ovals on the flat table.

Figure 9—When circumstances dictate use of an off-to-the side location for the pulpit that gives poor vision into the trough well, a table like the one shown here will provide visibility space between its rollers.



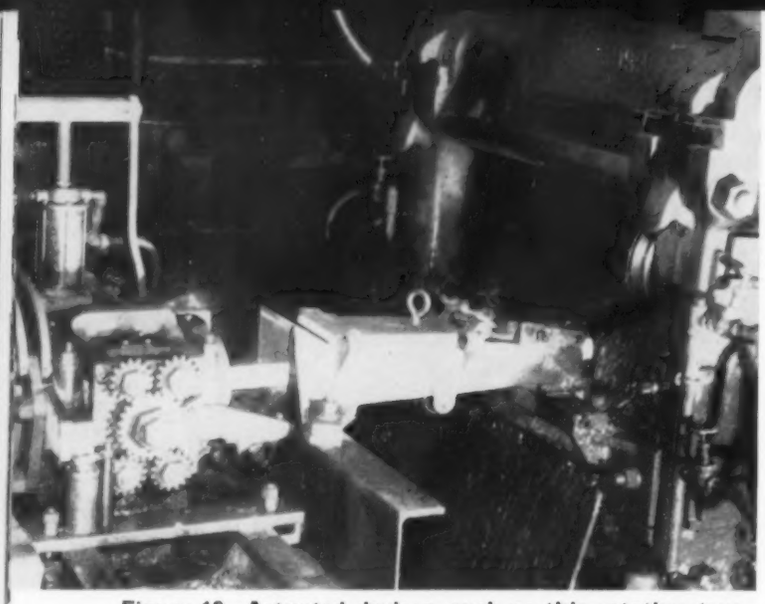


Figure 10—Actuated devices, such as this rotating trunnion, provide a more positive turning of the bars.

sufficient inertia to overcome the friction encountered in the guide. It is useful primarily for work pieces of elongated cross section which permit leverage to be gained for turning. Other devices, too numerous to mention, also fall into this category. Abutments are provided which engage and lift one side of the bar as it travels along transfer tables. As the bar travels forward, it eventually falls off the abutment, but now turned on its other side. Such a device would be applicable primarily to rectangular pieces. Recently a simple and effective device was developed accidentally due to a mechanical defect. In operation the work piece was being transferred laterally from table to table by a chain transfer. A stop was so placed on the transfer that it interfered with the bar about 1 ft from its back end. Upon engaging this stop the bar started to bend. Being of rectangular cross section, it immediately turned itself 90 degrees in order to bend about its weaker axis. After so bending the back end of the bar cleared the stop and the bent portion held the bar up on its narrow side until it entered into the next pass.

Actuated devices provide more flexibility of operation and more positive turning action. In open mills these devices usually take the form of a rotating trunnion as shown in Figure 10. These units should contain rollers to minimize friction on the piece, and the rollers should be readily adjustable so that the turner can handle a wide range of sizes without the necessity of replacing any parts. The method of adjustment should be such that the pass line is maintained at all times on the centerline of the trunnion. The trunnion should be mounted so as to permit it to float freely above the table rollers to accommodate irregularities in the shape of the bar as it is turned. At no time should the piece be lifted off the table rollers. If this is done, it will lose traction and entry into the mill will be made more difficult. A flag switch on the table is used to actuate the device. The most suitable flag at the present time appears to be a photoelectric unit with the pickup unit mounted on a portable stand so that the timing of the turner can be readily adjusted by relocating the unit.

Other actuated devices for specialized conditions are also seen occasionally. One of these consists of a number of cam-shaped discs arranged between the rollers of a table with their axes parallel to the roller axes. The discs are rotated as the work piece passes over them. The cam periphery engages the piece in such a manner as to turn it from one side to the other.

Modern continuous bar mills are generally arranged with alternate vertical and horizontal stands in order to eliminate twisting. However, for the sake of economy the roughing train may have all horizontal stands. In this case the bar must be twisted between passes. Friction twist delivery guides start the bar twisting as it leaves the pass and give it just enough twist so that it properly enters the entry guides of the next stand. Because this friction will persist for the entire length of the bar, serious scratching may occur; and for this reason roller twisters are preferred. These rollers are mounted in an adjustable trunnion which can be rotated to give the proper amount of twist.

It is also possible to twist bars between continuous stands with actuated devices. In this way the twisting operation may be made less critical in its setting and less apt to damage the piece. An application is a trunion turner twisting a $2\frac{1}{8}$ x $3\frac{3}{8}$-in. diamond in a distance of 19 ft.

When bars of small cross section are rolled, they generally become too long to handle as straight work so looping is resorted to. In this practice the front end of the bar is bent 180 degrees and fed back into the next pass while the piece is still coming out of the preceding pass. This looping was done manually for many years by catchers. It is still performed in this manner at critical points in some mechanized mills, such as when handling a lead oval. It is necessary here because of the difficulty of sticking the bar in the tight guides which are required on a finishing pass.

The mechanical device for looping is a repeater. The great majority of all present-day repeaters are the breakout type as shown in Figure 11. This unit consists

Figure 11—Shown here is a breakout-type repeater, a mechanical device for looping rod between stands. The open-top troughs guide the front end of the rod from pass to pass.

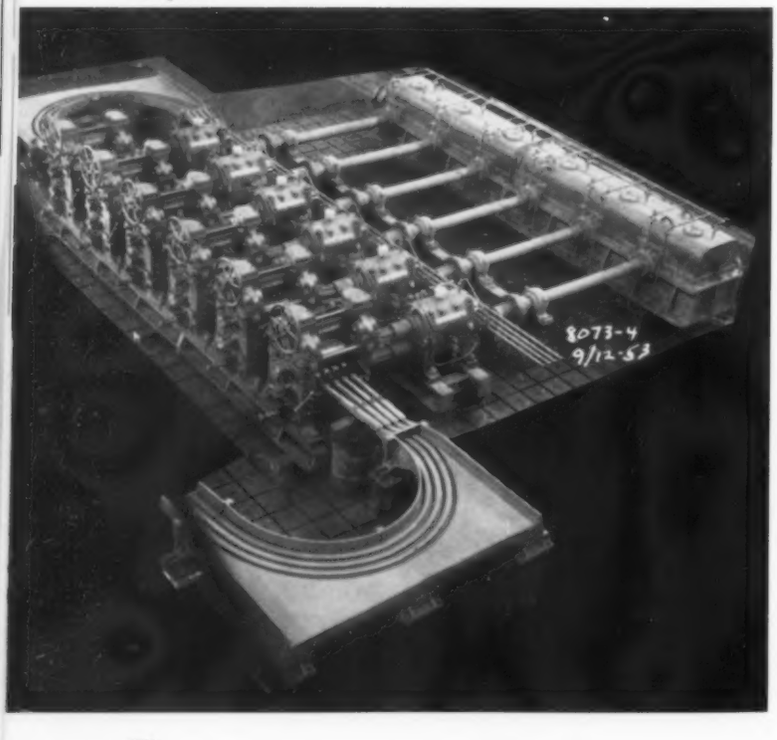


Figure 12—This equipment permits straight work and looping without removing any equipment from the mill stand. Here the crop shear, bar turner and discharge and entry troughs for straightwork are in position and operating. To change to repeating, the entire assembly is hydraulically moved.

of an open-top trough so arranged as to guide the front end of the piece from pass to pass. In most looping the piece must be fed into the loop faster than it is taken out by the following pass. Otherwise the piece will pull up tight and brake. In the special case where looping is done between separately-driven stands with individual speed regulation, it is possible to hold the loop quite constant by careful speed adjustment or to pull up slightly. Even in this case, during startup of a new section and until the mill has been adjusted, it is necessary to have a growing loop. In the case where the two stands are both driven at the same speed, the entire elongation of the bar between the two passes goes into loop growth.

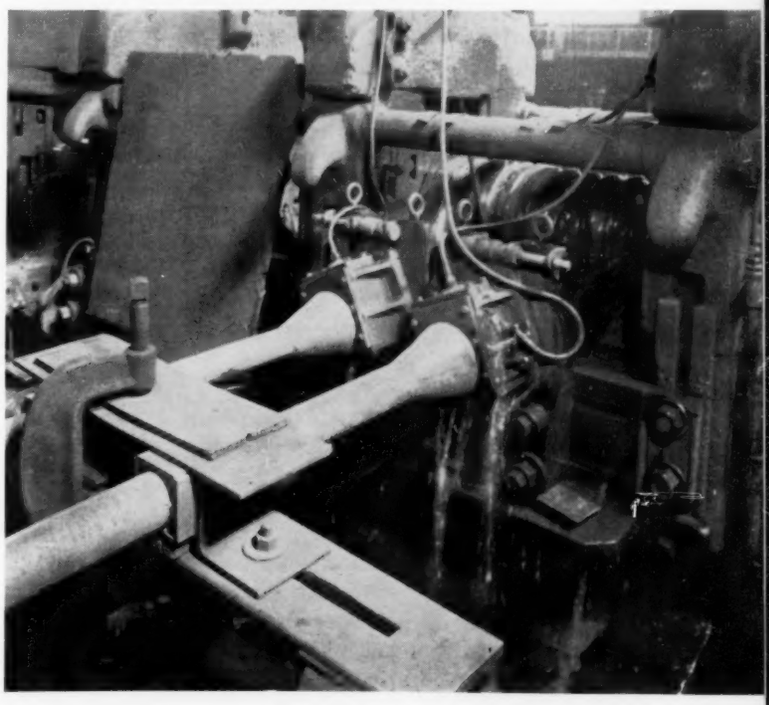
In the breakout type of repeater the trough must be shaped to permit the bar to buckle easily and escape from the trough immediately after it has entered the succeeding pass. This escape point is usually provided for by flaring out the outer wall ahead of and at the entry to the repeater proper. The remainder of the repeater trough is generally sloped inwardly at about 20 degrees from the vertical in order to restrain the front end of the bar from climbing out. In spite of this, occasionally bars will show a tendency to climb out as they approach the end of the repeater trough. They can sometimes be held down and directed into the entry bellmouth by putting a cover plate over the top of the trough for about 20 degrees back along the repeater and high enough above the trough to permit the loop to escape. Recently breakout repeaters have been made with the outer surface of the trough vertical and a lip at the top. This lip appears to give more positive control of the front end of the bar than does the more commonly used inward slope. One such repeater had this lip made up as a bolted plate which could be adjusted to secure the best operation.

In most bar mills the range of products handled is such that both straight work and looping must be accommodated. It has been common practice in the past to install repeaters on the mill standing when required and to remove them bodily from the mill area when straight work is to be done. A serious loss of time is thus encountered. For that reason equipment that will permit both straight work and looping without removal from the mill standing is generally favored at the present time. Figure 12 shows such an installation. As shown, the discharge trough and entry trough for straightwork, together with crop shear and bar turner, are in position and operating. To change to repeating the entire assembly is moved laterally by hydraulic power to bring the entry and discharge ends of the repeater trough in line with the mill.

To go around a repeater trough successfully, the work piece must be in such position that its weaker axis is being bent about the center of the repeater. Squares will place themselves in this position, but rectangular and oval sections are preferably started toward proper position by a twister as shown in Figure 13. These twisters should be mounted as close to the delivery guides as possible. In this case that place is on an extension of the rest bar to permit the piece to enter the twister at a point where not too much angularity of setting is required. The actual twisting surface should be a roller on anti-friction bearings to minimize scratching, and the entire twister should be mounted as a trunnion with a means of obtaining accurate setting of angularity and holding it. A scale should be provided so that once the proper setting for a certain section and grade is made and noted, that setting can be readily reproduced. Not only the degree of angularity of the rollers should be adjustable, but also the opening between the rollers so that a range of sizes can be handled.

It will be obvious that the twister can be set in either direction. When the edge of the piece that is away from the center of the repeater is twisted so as to be the top side of the piece when it is going round the

Figure 13—Shown here is a twister, a device that twists the bar into such a position that the bar will be bent around its weaker axis when entering the repeater.



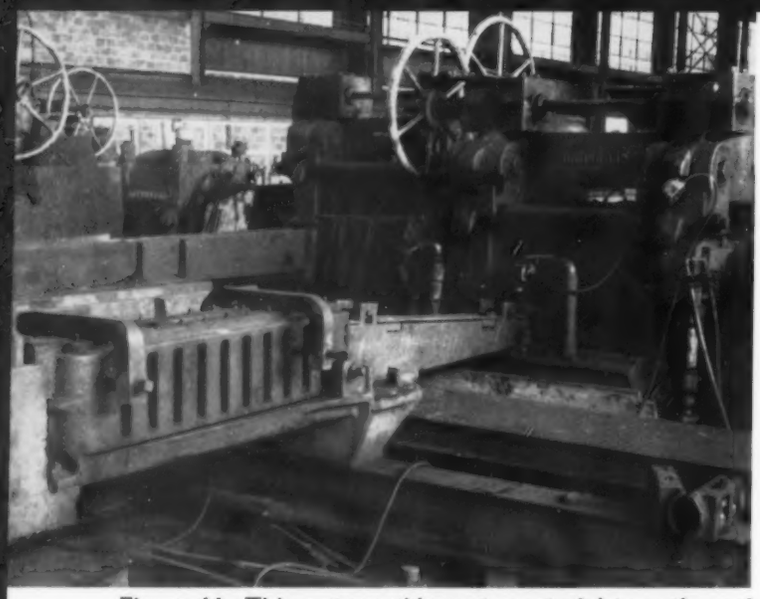


Figure 14—This entry guide system straightens the rod after it leaves the repeater and before it enters the last stand.

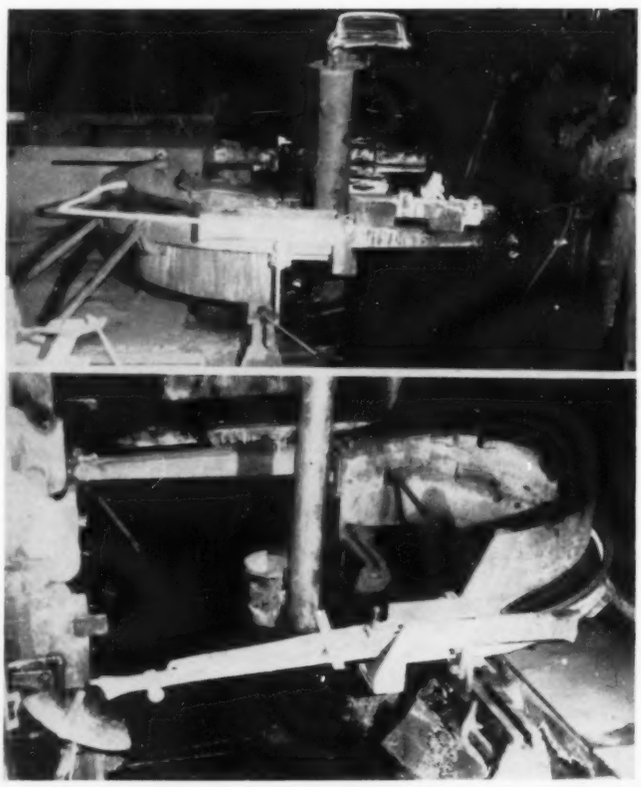
repeater, it has been "turned in." When the edge of the piece which is toward the center of the repeater is twisted to the top, the piece has been "turned out." There is no general rule which gives the proper procedure in this matter, but the repeating of each section must be considered in view of the basic considerations of breakout repeating. It is necessary, in all repeating, to contain the bar tightly enough that it will push its way as a column through the entry guides and into the succeeding pass. With a piece of small cross section this is a prime consideration, and care must be taken to avoid premature breakout. When "turning in" the bar is placed in such position at the breakout portion of the repeater that its stronger axis is resisting buckling, this practice, therefore, assists in giving more "push." Conversely, with a bar of large cross section the piece will have plenty of column strength to push itself into the next pass, but it may be too stiff to break out properly from the repeater trough. In a proper breakout the bar lifts smoothly over a considerable distance with a long gradual buckle. If the breakout provisions of the repeater are too limited for the size of the section being handled, a short sharp buckle will be obtained. If this buckle is too abrupt, the bar may fail to straighten out and continue through the succeeding pass. In order to minimize this latter tendency, it is desirable to "turn out" and thus present the weakest axis of the bar to the breakout section of the repeater.

Unfortunately, the matter of twisting is further complicated by the behavior of the front end of the bar. Once the piece has gone well into the radius of the repeater, the mechanics of its section will usually insure that it stands with its minor axis toward the center of the repeater. However, the twister is continuing to twist the bar throughout its travel through the repeater trough. When "turning in," this continuation of twisting tends to hold the front end of the bar against the bottom of the repeater trough, but when "turning out" it tends to lift the front end out of the repeater trough. With pieces of small cross section this matter is not of too much significance because the bar is generally too limp to lift itself out of the repeater any way. However, with bars of larger cross section the front end may show a definite tendency to ride up out of the repeater in the final third of the trough. Since the two tendencies described above are mutually opposing, especially with larger pieces, the setting of twists is a matter requiring some experience and thoroughness on the part of the roller. In the matter of securing proper breakout, a good compromise is also required when building the machinery. For heavy bars a smoother breakout is obtained with a long entry trough to the repeater, a proper trough cross section, and even a spring-loaded trough cover, giving a long breakout area. With pieces of small section these long troughs invite premature breakout.

It was mentioned above that the work piece must push itself as a column through the entry guides and into the following pass. For consistently successful repeating, conditions for this push through must be optimum at all times. The worst condition for sticking in the guides occurs when the piece has a knuckle on the front end. This knuckle is usually caused by backlash of the rolls and spindles, and for this reason it is very desirable that when repeating is to be undertaken, universal spindles be applied. It must be stated, however, that only a small minority of the looping mills in this country are driven by universal spindles.

The work piece may not only have a knuckle from the preceding pass, but it leaves the repeater itself with a large radius which must be straightened out before the piece can go through the entry guides. When the pieces are not too stiff, and when the entry guides can be set loosely, a simple entry trough is adequate. In the rolling of alloy steels, however, a high degree of hot stiffness is encountered; and it is necessary that the entry trough straighten out the bar with a minimum of resistence. Figure 14 shows an entry guide system

Figure 15—This pair of repeaters is adapted to three high mills for changing elevation. The path of the repeater lies wholly within a single plane as opposed to a spiral design.



composed of three sections. First comes a trough with adjustable roller sideguards. These sideguards are set open to receive the bar from the repeater and gradually converge toward the mill so that the bar will be straightened out against the rollers with a minimum of friction. Next is a short portable trough in which cast iron inserts can be placed. These inserts rather closely conform to the section of the bar and provide further straightening. In addition, this section can be readily removed for access to the guides and for the entry of trial bits into the mill. The entry guides themselves should be short. If roller guides are used, one or, at the most, two sets of rollers should be included. The guides must be set as loosely as possible. All this is done to permit bent and split ends to pass through. Where a tight guide is required, a spring-loaded guide box or a mechanical loosening and tightening device should be considered.

When repeating in 3-high mill trains, it is of course necessary to change the elevation between passes. There are many opinions as to whether it is easier to repeat from top to bottom or bottom to top. Figure 15 shows a pair of repeaters, one repeating a square from bottom to top, and the other repeating the succeeding lead oval from top to bottom. Most repeaters for 3-high mills of this sort have been constructed in the past on a spiral path, i.e., the repeater trough starts up (or down) immediately and continues to rise at a constant rate throughout 180 degree. When the repeater shown in Figure 15 was to be constructed, experimental models were built to determine whether the spiral, which is relatively difficult to construct, or a repeater path lying wholly within one plane, with the delivery side merely lifted or lowered an appropriate amount above or below the entry side, was more satisfactory in performance. The experiments indicated that there was very little to choose between the two methods. Therefore the simple plane design was adopted. Now that they are in operation, the mill operators feel that they give a better repeating action than the more common type of spiral repeater which is used elsewhere in the mill. A distinct advantage lies in the elimination of the abrupt change in slope between the entry and delivery troughs and the repeater trough which is obtained with a spiral type repeater.

A very special example of repeating, which is not used in this country, but which never fails to excite the interest of visitors to Europe, is the overhead repeater which loops from one pass on a 3-high roughing mill to the next succeeding pass in the same stand above or below it. A typical unit is shown above in Figure 16. At the bottom of this figure these repeaters are shown in operation on the 16-in. intermediate rougher of a 12-in. light-section mill at Darlington-Simpson. They are used for the lighter sections only. A $1\frac{3}{8}$-in. square and a 2 x $1\frac{1}{8}$-in. diamond are repeated at about 520 fpm.

With painstaking care on the part of the operator to develop and record proper settings for all items of equipment, breakout repeating can be carried out very successfully for a large range of grades and sizes of steel. Norlindh, in the Journal of the Iron and Steel Institute of April, 1954, describes the repeating of ovals and rounds down to 0.198-in. diam at speeds 4300 fpm. The repeaters in Figure 20 repeat a square and lead

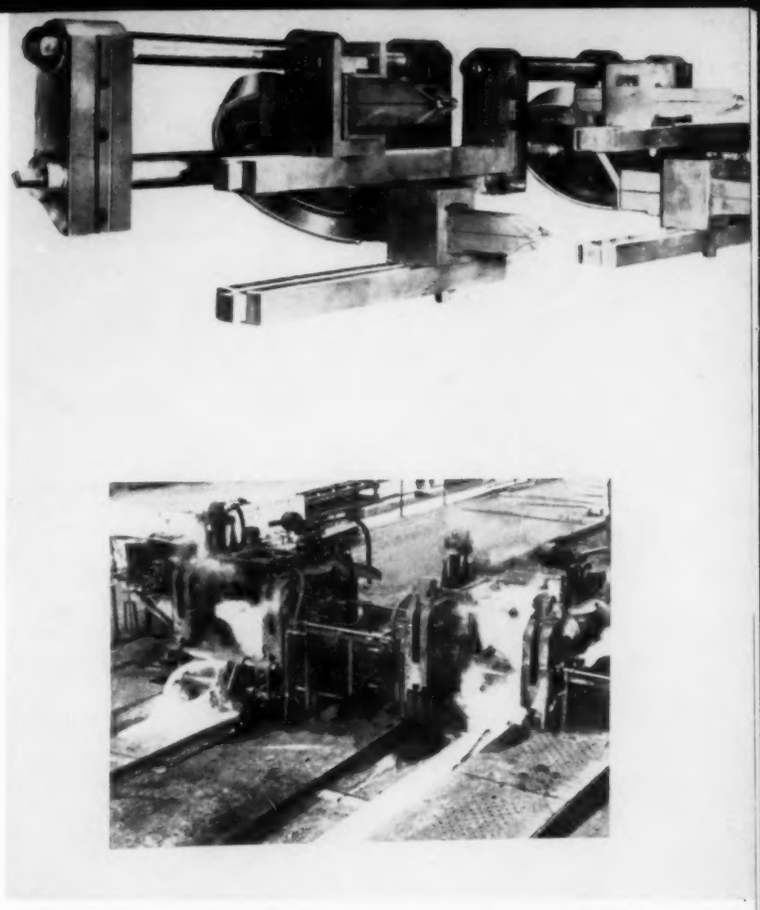


Figure 16—The repeaters, shown above in detail and below in operation, are the overhead repeater used in Europe.

oval to make bars from $\frac{3}{8}$ to $1\frac{1}{8}$ in diam, and a repeater in the roughing train of this same mill repeats pieces up to $2\frac{5}{8}$ in. square. It should be noted, however, that this mill rolls carbon steel only, and that the entire product is reinforcing bar. As the grades of steel multiply, tolerances tighten, and different shapes are produced, the operation of breakout repeaters becomes more and more critical.

In order to make the operation of repeating less critical as well as to make possible the repeating of additional sections such as flats and angles, various forms of mechanical escapement repeaters have been developed and are becoming more popular. In such a repeater the work piece is entirely contained during the period of passage of the front end from pass to pass. Once the piece is entered into the succeeding pass, the repeater is opened by mechanical means to permit the piece to elongate onto a looping floor without restriction. Figure 17 shows a continuous strip mill in which the direction of rolling is reversed between the roughing and finishing train. The speed of the finishing train is independently adjustable so loop growth can be held to nothing. After the piece is around the repeater, the outer wall is lifted mechanically to give the loop freedom to grow in the event transient changes of temperature or mill speed make such growth necessary. However, the opening of the outer guide is not critical and can be accomplished in leisurely fashion. Such a repeater can also be constructed with a distance of several feet between the outer and inner guides, and the mill can be adjusted to have a slowly decreasing loop in which case the outer guide need not be lifted at all. However, even in this case the outer guide should be liftable for the time of mill startup when speeds are not so accurately adjusted. A variation

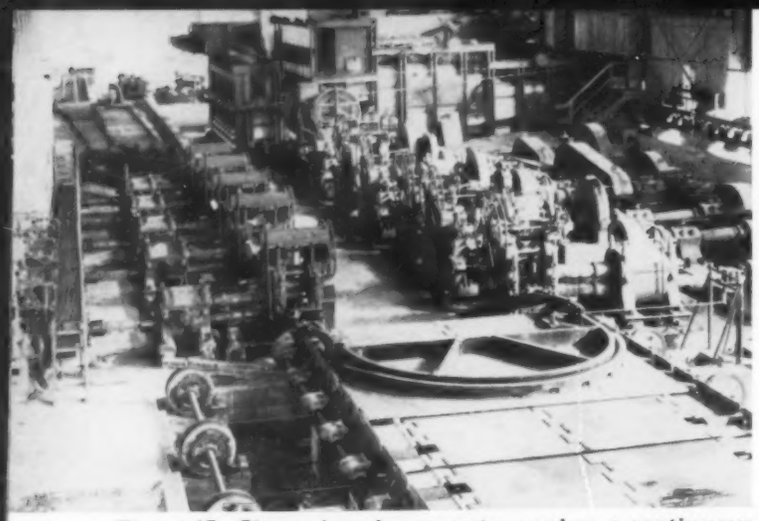
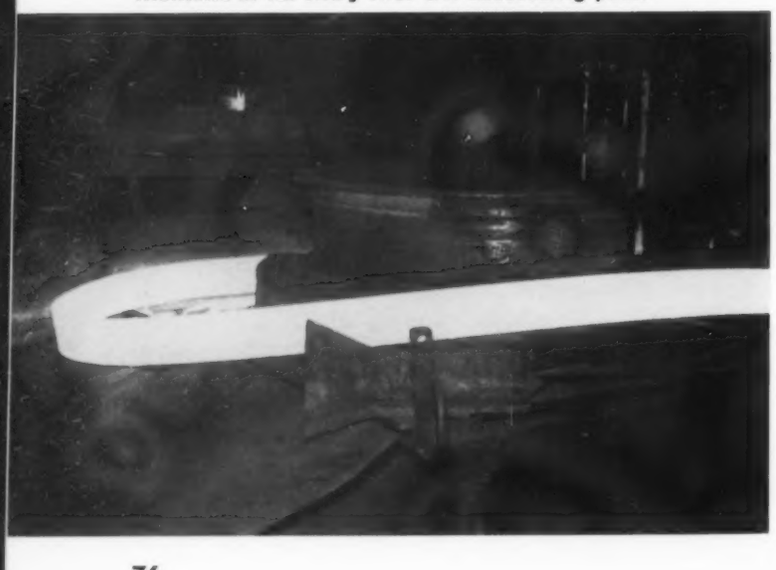


Figure 17—Shown here is a repeater used on a continuous strip mill to reverse the strip direction from the roughing to finishing train. After the piece is around the repeater with its lead end in the finishing stand, the outer wall of the repeater is mechanically lifted to give the loop freedom to grow in the event of transient changes in its temperature or the mill speed.

Figure 18—The speed and timing of the opening of this outer guide of the repeater shown here is made less critical by making its initial movement in the direction of the growing loop. This is accomplished by providing pivots for swinging the guide out and up instead of lifting it vertically.

Figure 19—In this type of repeater the pivoting entry trough lifts the bar clear of the repeater trough at the moment of its entry into the succeeding pass.



of this action is shown in Figure 18 in which the outer guide swings up and out of the way on pivots. The outer guide moves in the direction of the growing loop thus making the speed and timing of opening less critical than when the outer guide is lifted straight up.

A relatively simple device for repeating narrow flats is shown in Figure 19. In this type of repeater the pivoting entry trough lifts the bar clear of the repeater trough at the moment of its entry into the succeeding pass. Such a repeater is relatively inexpensive, but the timing of the lift-out operation is critical. It has been used on skelp up to six in. wide.

Figure 20 shows a repeater in which linkage is arranged so that the outer trough swings away from the center of the repeater and up at the same time making release of the growing loop rapid. The escapement is accomplished by an air cylinder located inside the periphery of the repeater. It is operated by a solenoid valve and photoelectric unit. The pickup of the photoelectric unit is shown mounted on the entry trough just ahead of the entry guide. It is necessary, in such an application, that the pickup unit be mounted very close to the trough and in such a position as to scan the entire trough so that it will not miss the passage of the piece. It has been found that heat from the passing bars raises the temperature of the pickup unit and its surroundings and changes the units operational characteristics making its performance unreliable. A satisfactory solution to this difficulty was found by enclosing the pickup unit in a small hood and introducing a jet of compressed air from the mill air supply to keep the ambient temperature more or less constant. A proximity switch may prove to be a better application. Also located within the periphery of the repeater is the trough and bar turner for straight work. Located on the same ways as the repeater and beside it is a delivery trough to handle the work piece from the preceding stand. To obtain flexibility of center distance for straight work, this additional trough is made separately from the repeater itself.

Mechanical escapement repeaters are more costly than the simple breakout type. Because they are mechanical devices, they require operation and maintenance. However, their advantages are significant:

1. Because the work piece is entirely contained while the original loop is being formed, it has a maximum of "push" to force it through the entry guides and into the succeeding pass.
2. Once the bar has entered the succeeding pass and the loop has been formed, the loop is free to grow without any danger of excessive buckling.
3. Since all straight work and repeating is done on a flat surface or roller table, there is a minimum of scratching such as encountered in breakout repeaters when the bars run out of and back into the repeater trough.
4. Sections which cannot easily be induced to break out of a fixed repeater, such as flats and angles, can be handled.

Operators who have used both types of repeaters appear to favor the use of the mechanical escapement repeater for applications where flexibility of grade and section are required.

In hand mills the bar can be cropped periodically by

the familiar constant-running alligator shear into which the piece is inserted by hand by catchers. When bar mills are mechanized, the conditions change and provisions for cropping at appropriate points must be made in the mill design.

Figure 21 shows a hydraulically-operated shear at an 18-in. 3-high roughing stand. Before the last pass is taken, the operator drags the bar into the throat of the shear at which point a flag switch trips it. A similar type of shear located further back on the end of the table will crop the back end of the bar automatically when it is run into the throat of the shear by the table operator.

Figures 7 and 12 show stationary shears arranged in the line of rolling. Here the work pieces are stopped, either by the operator or by an automatic gage, and cropped before being moved into the succeeding pass. Such an arrangement is quite satisfactory for straight work.

When repeating is involved, the piece cannot be stopped; and a flying shear such as shown in Figure 22 is required. Because this bar is on its way to another repeater and has a fairly small cross section, a sliding guide pipe is provided on the delivery side of the shear. This pipe is retracted at the time of shearing in order to provide clearance for the shear blades and dropping space for the crop. Immediately after passage of the front, the guide pipe is pushed through the throat of the shear to contain the bar while it is being pushed around the next repeater.

Up to the present time most of the manipulating devices which have been described have been operated manually by operators located in suitably-placed pulpits. The photoelectric unit has become more reliable in operation and is now understood and accepted by many mill operators so that a greater degree of automation is being built into modern mills. Such automation accomplishes two purposes. Primarily it eliminates the need for costly operators. Secondly it increases the speed of operation of the mill because the automatic controls are instantaneous and tireless in their operation.

It should be pointed out that while the cost of these manipulating devices is considerable, the cost of doing this manipulation by hand is apparently even more so. Most modern bar mill installations are approached from the viewpoint that labor and operators alike must be eliminated wherever possible. This tendency is intensified by the inflexible attitude of union leadership with respect to reducing mill crews gradually as mechanical improvements are made. Oftentimes it would be desirable to install a mill with relatively simple handling equipment; and, as the mill got into operation, handling devices could be added as the need for them became apparent. Most mill operators today are apparently convinced that once a new mill has gone into operation with a given crew that crew will be there for the life of the mill. Therefore the maximum degree of mechanization practical must be installed at once even though this increases seriously the original cost of the mill and complicates its startup.

It should also be noted that none of the manipulating devices described above are as flexible as a man with a pair of tongs. Every time one of these devices is added to a mill, flexibility is impaired somewhat. Therefore,

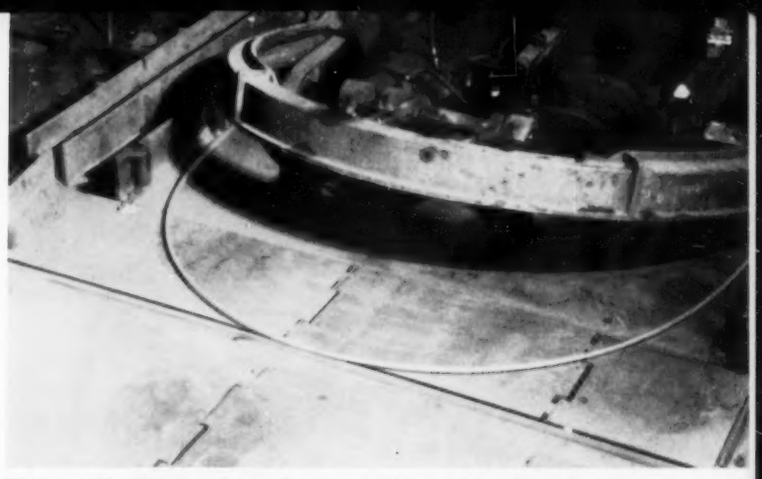
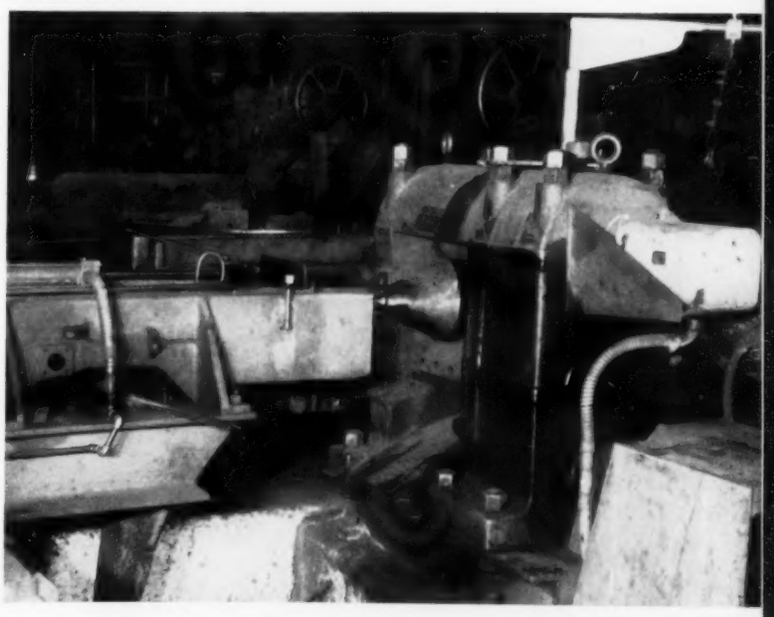


Figure 20—Shown here is a repeater with linkage that swings its outer trough away from the center of the trough and up at the same time. Thus release of the growing loop is rapid. The linkage is powered by an air cylinder and controlled by a solenoid valve and a photoelectric unit.

Figure 21—Shown here is a hydraulically-operated shear located at an 18-in., three-high roughing stand. Before the last pass the operator, as he is doing here, drags the bar into the throat of the shear at which time a flag switch trips the shear for operation.

Figure 22—When the line has repeaters, it cannot be stopped. Cropping is done by a flying shear such as the one shown here.



in mills requiring a high degree of flexibility mechanization must be studied very carefully to make sure that the devices proposed will not take more time to change than they save in operation.

Mechanization and automation, although often installed for the express purpose of reducing labor costs, almost invariably increase production rates. These factors point the way toward the automatic bar mill of the future.

Discussion

PRESENTED BY

E. E. DAVIS, Superintendent of Hot Mills, Carpenter Steel Co., Reading, Pa.

WILLIAM H. BOBLITZ, Assistant Superintendent Bar Mills, Stainless Steel Div., Jones & Laughlin Steel Corp., Detroit, Mich.

E. C. PETERSON, Vice President, Rolling Mill Equipment Div., Birdsboro Steel Foundry and Machine Co., Birdsboro, Pa.

E. E. Davis: One of the things that we have noted was that although automatic equipment cuts down the crew size considerably, the crew that remains for operation of the mill must be a higher trained group.

Even though we have the better trained people to operate the mill, there is always a danger of ruining good equipment by poor operating practice. I would like to know what devices would be put on this equipment to safeguard it in case the people are not good enough to operate it properly.

William H. Boblitz: There is one detail I believe should not be overlooked; that is mechanically twisting a square during repeating. We all are more concerned with twisting ovals and put little importance on the square because it is normally twisted by crossing the rolls. There are times when square twisters become necessary due to conditions which may be present such as: large size square, grade of steel, close mill stand centers and temperature of steel. Any one or more can cause crossing the rolls to such an extent that off-section and excessive roll-pass wear become apparent.

Member: Some of the pitfalls of mechanical manipulation, particularly for the small mill operator, were mentioned in the paper. You get into situations where it takes you longer to take out your equipment and replace it than it does to change rolls. This ultimately gives you reduced tonnage. I think that a lot of the small mill operators have been reluctant to go to mechanical devices. I would like to say that we have gone from a complete hand mill to a fully mechanical mill. It will be the salvation of the small mill operator.

E. C. Peterson: It is a constant struggle for any machinery builder to build foolproof equipment because operators will do the most amazing things at times. The first consideration, of course, must be safety of personnel. In hand looping, for instance, we put whipping posts and turtle backs on the floor so that in case of a wreck in the mill the bar will not pull up and cut the catcher in half. The more agile catchers will turn a loop in front of them so that they will never be in the position of depending on a whipping post for safety.

Close clearances between moving parts in places where a man may have occasion to put his foot or hand, require care to have sufficient clearance for his fingers and toes. Also, mills should be provided with adequate working platforms at the points where the operator must have access to the mill. This will keep him out of danger spots and will eliminate the need for dangerous climbing.

A similar problem is the question of circulation around the mill. I think every mill layout should be reviewed with regard to where the men are apt to want to go and from where. Proper crossovers and walkways must be provided so that they will be able to stay out of danger zones and still get quickly where they must go. In regards to the protection of the machinery itself I suppose the most useful device we have is the electrical interlock. We use it, for instance, in lubricating systems where automatic lubrication is provided. These are often connected so that the operator must start the lubricating system before he can start the mill. That prevents him from running the mill without any lubrication. In circulating oil systems we may go further and provide pressure switches so that when there is something wrong, with or without the lubricating motor running, and pressure is not developed, the mill will either not start or will shut down. On such systems we generally provide two pumps. If the service pump fails, it will sound a warning.

In devices such as a transferring bar turner the preceding transfer is prevented from delivering a bar into the next pass until the succeeding bar turner is in position to receive it. This is accomplished by interlocking.

There are many interlocks put on equipment to try to prevent mechanical interferences. For instance, sometimes the kick-off in a back shear table can interfere with the gage head. By electric interlocking one of the units can be locked out of position while the other is in position so that they cannot interfere with each other.

Dependent motions can often be secured by interlocking. For instance, a crop conveyor for the little automatic crop shear that is shown in the paper must be running for the shear to cut. This prevents possible jamming of crops on the conveyor or in the trough.

Electrical devices, such as solenoid valves, should be set to fail safely. Many flying shears and bar shears, for instance, are operated with air-operated clutches that are usually controlled by a solenoid valve. This valve should be arranged so that if power is lost, the valve will go to such a position that the shear will not operate. If it were arranged that the valve would go to a position where the shear would cut, the failure might cause a serious accident when power is restored.

Many mechanical units have limits to their stroke. If you go beyond that stroke, there will be a wreck. The usual way of trying to prevent such an occurrence is with overtravel limit switches, which can be in the form of track switches that are directly activated by the moving part. They can be connected to the drive somewhere in the form of a rotating cam switch which is set to prevent the drive from operating beyond its limits of travel.

There is a special application illustrated by the transferring bar turner. The pinch roll must follow the mill drive, and it is necessary to have them run together without constant overloading of the pinch roll drive. Here a variable voltage arrangement with current limit has proved quite effective. ▲

A Constant Horsepower Computer—Permitting the Use of Slip Couplings for Winder Drives

by P. R. Gravenstreter,
Engineering Manager,
The Clark Controller Co.,
Cleveland, Ohio

. . . . the regulated constant horsepower required to wind strip on a reel at constant strip tension can be obtained from an a-c induction motor and an electric slip coupling whose excitation is controlled by a constant-horsepower regulator . . . .

THE aim of every engineer when designing a system is to select a set of components that will produce results equal to or better than existing systems insofar as reduced cost and performance are concerned. With this fundamental point made, the idea may be expanded to include the reeling of processed material. The advent of continuous wire drawing, continuous strip processing and other continuous web processes brought about many problems in addition to the problem of proper reeling of the finished material.

It is generally conceded that a good coil—one that has straight edges and uniform hardness and is self supporting and non-telescoping—may be wound by adequate control of tension in the material providing the strip is good. One school of thought contends that a programmed or predetermined variation of tension in the strip as the coil diameter increases produces the best coil. On the other hand, there are those who think the best coil is wound with constant tension. Because this question is largely a matter of opinion, it will be left for discussion and investigation by others. For the purposes of this paper, consideration will be given only to the problem of adequate tension control. The system to be described permits either system of tension control to be incorporated.

It is the intent of this article to deal in part with some of the problems of constant tension winding using less conventional components that result in a saving of first cost and suitable characteristics for good coil winding. In addition, the paper will demonstrate how a simple device may be used as a computer to produce an electrical output proportional to the product of speed and torque.

To evaluate the computer output quantity it will be necessary to review some of the basic concepts involved in reeling strip using core type mandrel winders with constant tension in the web of material a requisite. Figure 1 indicates the mathematics used in determining one of the fundamentals.

It is demonstrated that:

$$Hp = \frac{TS}{33{,}000}$$

T = tension in strip in lb
S = speed of line in ft per sec

It can be stated that constant tension winding at a given speed requires that the rate of work be a constant. At a strip speed of 100 fpm and a tension of 330 lb the horsepower required for winding is 1.0. At the motor shaft the product of speed (rpm) and torque, which is horsepower, must be held constant, or mathematically:

$$Hp = \frac{\text{speed (rpm) torque (lb-ft)}}{5250} = \frac{nt}{5250}$$

n = speed in rpm
t = torque in lb-ft

The goal, therefore, in any constant tension winding system using an electric motor will be to hold the product of speed and torque at the motor shaft constant. The d-c motor is a good choice because both torque and speed are controllable by adjustment of the motor shunt field flux. It is a matter of record that the torque developed at the shaft of a d-c shunt wound motor is proportional to the product of shunt field flux and armature current. Mathematically this may be written:

$$t = K\phi I$$

When

K = motor constant (turns, poles, paths, etc.)
ϕ = shunt field strength
I = motor armature current

Shunt motor speed is, in general, related to the motor

terminal voltage when the losses are assumed negligible and can be disregarded. Here it can be shown that speed is proportional to the motor terminal voltage and inversely proportional to the shunt field flux, or mathematically:

$$n = \frac{V}{\phi} K$$

n = motor speed
V = motor voltage
K = motor constant
ϕ = shunt field strength

For a shunt-wound motor the product of speed and torque may be written:

$$Hp = \frac{nt}{5250} = \left(\frac{V}{\phi} K\right) (K\phi I)$$

or

$$Hp = K_1 IV$$

K = motor constant

$K_1 = K_2$

ϕ = motor field strength
V = motor terminal voltage

If strip speed is to be held substantially constant and the motor terminal voltage V is essentially constant, the computation reduces to $Hp = K_2 I$. Stated simply, constant tension at constant line speed requires holding the motor armature current constant.

When a d-c shunt-wound motor is used as a drive for the winder, constant tension requires constant armature current. It is apparent that consideration will have to be given to motor torque because the radius of the coil continues to change as the coil builds up. See Figure 1.

At some instant in coil winding operations, select two values of coil radii r_1 and r_2 with tension, T, held constant. The torque required of the motor drive under these conditions is:

$$T = \frac{t}{r_1}$$

and

$$T = \frac{t}{r_2}$$

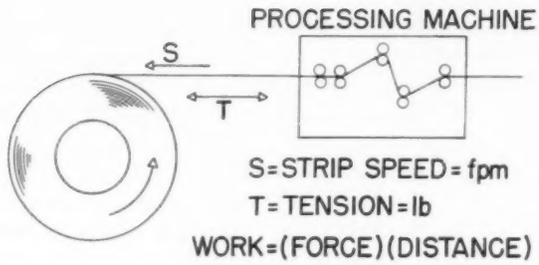
T = strip tension held constant

It is obvious that as the coil diameter increases, more torque is required to hold the tension in the material constant. In the d-c motor torque is equal to:

$$t = K\phi I$$

K = motor constant
ϕ = motor field strength
I = motor armature current

The current must be held constant for the reason previously stated. In order to provide the required constant tension a change in field strength is required to satisfy the constantly changing torque demand at each value of coil diameter. Stated differently, as the coil diameter



$$hp = \frac{WORK}{RATE} = \frac{TS}{RATE} = \frac{TS}{33{,}000} \quad 1\ hp = 33{,}000\ ft\text{-}lb/min$$

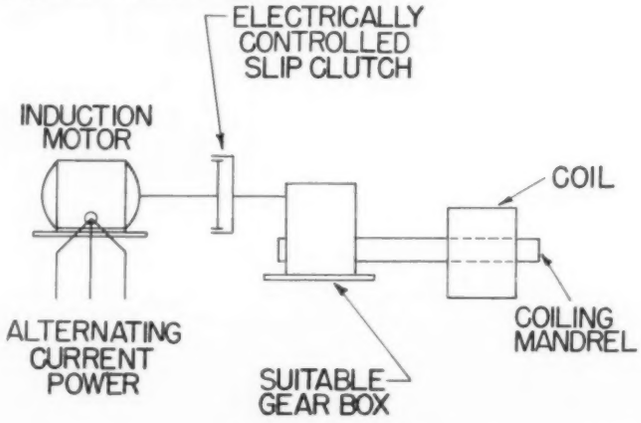
Figure 1 — A core type mandrel winder reel requires a drive motor that is regulated for constant horsepower for winding strip at constant tension.

increases, the torque required increases necessitating an increase of motor field strength.

Further consideration of the problem discloses that coil rpm must decrease as the diameter of the coil increases. This requires that the motor speed decrease as coil diameter increases. Fortunately, a d-c shunt-wound motor possesses characteristics that are suitable for application to a core type winder as its drive. As the coil diameter increases, an increase of motor torque is required to hold constant strip tension, and this increased torque is provided by changing field strength. When the field strength is changed, the motor speed is also changed. It was shown that motor speed is proportional to the armature voltage divided by the field flux; or, stated another way, motor speed decreases as field strength increases. Fortunately, the d-c motor torque and speed varies as required when the field strength is changed. All of the conditions required for constant tension winding may be met by using a d-c shunt-wound motor.

D-c motors and required supporting a-c to d-c conversion equipment are relatively expensive when compared to the standard a-c squirrel cage induction motor. The a-c induction motor is basically a constant speed device. This prevents its use as a power source for a coil winder. However, if additional equipment, such as a slip coupling, is used, the speed problem is resolved.

Figure 2 — Instead of a d-c motor and associated control, a less-expensive a-c induction motor can be used as the drive motor if a slip coupling whose excitation is controlled by a regulator circuit is added to the system.



As outlined, when constant tension is desired, torque proportional to coil diameters is required of the a-c motor.

Consider the mechanical equipment as outlined diagrammatically in Figure 2. The essential components required for winding a coil at constant tension have been included. They include the motor, slip or speed adjusting device, torque control and mechanical means for supporting and driving the coil. The system permits reasonably constant tension winding by adequate control of the excitation of the slip clutch. This involves satisfying many conditions, each of which must be recognized and programmed to provide a satisfactory result. Some of the conditions that must be met are as follows:

a. Torque transmitted by the clutch must be proportional to the diameter of the coil.

b. The slip across the clutch must be proportional to the diameter of the coil.

c. The process speed of the strip must not disturb the system.

d. Provisions must be made for inertia compensation when winding certain materials, or more specifically when the tension produced approaches the yield point of the material.

e. The operation must require a minimum of operator attention.

With these conditions as requisites, an electrical scheme must be evolved to permit the use of the proposed components. Certainly it will be necessary to measure coil speed so that the necessary slip across the coupling will be provided. In a specific sense, the slip of the coupling will be related to the coil diameter provided line process speed and a-c motor speed are held reasonably constant. Slip may be measured by employing a well known device, the tachometer generator. As indicated in Figure 1 earlier in the paper, the product of speed and torque at the coiler shaft must be held constant to provide constant tension. Since the process speed is varied by changing conditions or by operator manipulation, the coiling shaft speed is influenced by two factors, process speed and coil diameter. By multiplication of speed and torque in a simple computer, an electrical output proportional to the product of speed and torque may be used to supply a portion of the signal field excitation of a regulator. The key for the system to be used may be found in any ordinary wound-field tachometer generator or any generator operating in the linear portion of its saturation curve.

As an illustration of the actual process involved, consider the equation for the voltage generated by a generator.

$$E = K\phi nN$$

N = number of conductors in series
n = rotational speed rpm
ϕ = field flux
K = generator constant

With the case in point, the number of conductors in series is a constant and will be combined with the constant K. Therefore,

$$E = K\phi n$$

Visualize the tachometer generator geared to the coil supporting and winding shaft at a suitable gear ratio. If the field excitation is related to torque, then E from the equation is proportional to horsepower because the coil speed is measured by the speed of the tachometer armature. To clarify this connection and the necessary components refer to Figure 3.

The tachometer output voltage T is allowed to adjust the regulator to the correct value of horsepower as required for a given value of coil speed. By holding the product of speed and torque constant and metering process speed, constant tension results. To detail further the problem of converting torque to an electrical quantity a current transformer with a resistance will produce an output voltage proportional to motor line current. However, line current differs from torque by an amount substantially equal to the no load losses. Shown in Figure 4 is a typical line current vs motor torque curve of an average induction type squirrel cage motor.

The actual current output in a rectified form can be

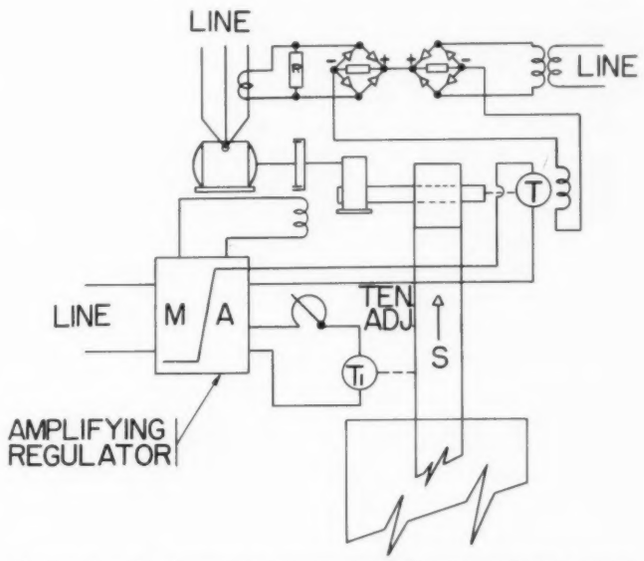
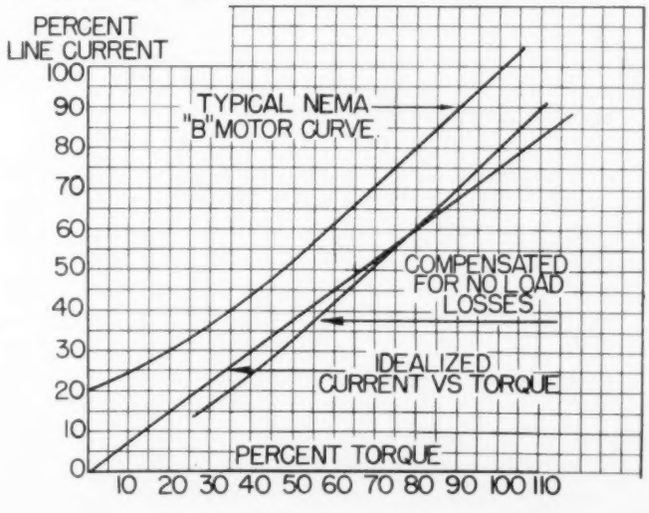


Figure 3 — Reel speed is continuously adjusted by a regulating system that has a feed-back loop which automatically changes slip coupling excitation to provide the coupling slip required to maintain constant strip speed.

Figure 4 — The near proportionality of the line current vs motor torque curve of a NEMA B induction motor makes possible a continuous measurement of motor torque by motor current detection when a bias voltage is used.



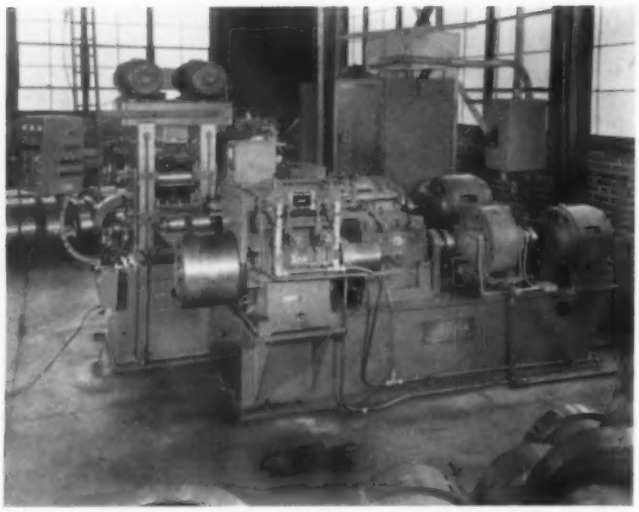


Figure 5 — This strip winder reel is powered by an a-c induction motor through an electrically-controlled slip coupling and a gear reducer. The control components include tachometer generators, a current transformer, control current rectifiers and transformer, and an amplifying regulator.

made to approach the idealized curve by subtracting the component of line current resulting from the no load losses. For this purpose a d-c fixed voltage is algebraically added to the output voltage of the current transformer. At the higher load points on the curve, output voltages are reasonably proportional to motor torques. A wound-rotor type of motor might be substituted, at a higher cost, to provide more accurate signaling because its rotor current can be shown to be proportional to the motor torque. This torque signal controls the generator field strength by its connection to the generator field as an excitation source. The generator, being driven by the coiler shaft, produces an output voltage equal to the product of speed and torque. By producing a signal that is proportional to the horsepower required to wind a coil at constant tension, a signal is available for programming a regulating type of amplifier for control of the slip clutch excitation.

By using strip or process speed as the basic measure of horsepower, the regulating amplifier is made to compare desired set horsepower with the actual produced horsepower. In evaluating the difference of the two signals, the regulating amplifier acts to correct the error difference in the signals thus bringing the system to equilibrium. This is brought about by adjusting the clutch excitation to such a value that the output from the computing tachometer generator is substantially equal to the desired output as set by the process-speed-measuring tachometer generator.

The characteristics of the clutch slip vs torque curve at specific excitations is relatively unimportant because the regulating system has a feed-back loop consisting of the torque sensing circuit and its entry into the regulating amplifier input circuit. By this method of connecting, changes in line speed and changes in coil diameter are compensated for by the regulator amplifier without any operator attention. Any irregularities, such as poor line speed maintenance and heating of the components (except the computing generator) are all resolved by the regulating amplifier.

In support of the workability of such an arrangement reference is made to Figure 5. Standard squirrel cage motors with NEMA B design have been selected to power the equipment. Liquid-cooled, eddy current slip couplings were used, for one reason, to get rid of some of the noise problems created by air-cooled magnetic slip devices. The liquid-cooled unit also provides a smaller device for equivalent torque ratings than the air-cooled design. Conventional components have been used to provide the usual operational functions. These include start, stop, jog, stall, tension adjust, etc. An exception, however, is the use of magnetic amplifiers for the regulating amplifiers. Single stage, specifically designed toroidal type units have been used to reduce maintenance to a minimum. The mill was placed in production in approximately one hour by non-engineering personnel after installation contractor wiring had been checked.

With the constant horsepower computer available, many other possible combinations of slip clutches and a-c motors may be suggested. An all a-c system was used except for the low energy signal circuits of the regulators. In general, the use of long life components and the absence of d-c devices makes the system attractive to the small industrial user who by virtue of his size is not equipped to handle a complicated system. With the simplicity of the a-c system, the equipment involved requires less floor space and no expensive foundations, both of which indicate it will have less installed cost. In most cases, the cost of the drive power to the input shaft of the gear reducer is less than with conventional d-c machines.

Several small ferrous and nonferrous rolling mills have been equipped with drives and components for constant tension winding. In one case a system has been supplied for reversing operation. This installation at present is operating unidirectional for mechanical reasons, but is fully equipped for reversing service.

Discussion

PRESENTED BY

A. S. URANO, Metal Rolling & Processing Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

P. R. GRAVENSTRETER, Engineering Manager, The Clark Controller Co., Cleveland, Ohio

A. S. Urano: The author has described an ingenious method for obtaining essentially constant horsepower control for winding reel drives, and I am sure that such a system will provide adequate electric control when properly applied.

In the steel industry the application of the winding reel drive runs from the fairly small and simple slitting and recoiling lines to the large, high-speed tandem mill drives. It would not be economically sound to provide for the slitting line the same reel drive system developed for the winding reel of a five-stand tandem cold mill. Similarly, it would not be wise from an engineering standpoint to supply a tandem cold strip mill reel drive with the electric system developed for a small slitting line reel. It is important, therefore, to consider both economic and engineering factors when applying an electric system.

I would like to mention some of the factors which

may limit the field of application of the system described by Mr. Gravenstreter.

1. Strip process speed range—As the speed range requirements of a process increase, the efficiency of the coupling drive system decreases when compared to a d-c drive system.

As the drive horsepower requirements increase, this loss in efficiency can become an important economic factor. Consider, for example, a 200-hp drive operating at 50 per cent process speed, two shifts a day, six days a week, or a total of 4992 hr per year. The total input to the adjustable voltage d-c drive, including motor generator set losses, is 45 per cent or 90 hp less than for the coupling drive. This amounts to a saving of approximately 335,000 kwhr per year. At $0.01 energy charge and amortized over a three-year period, an additional first cost expenditure of approximately $10,000 for the d-c drive over the coupling drive is justified.

2. Coil build-up range—In many steel mill drives coil build-up ranges of 3 and 4 to 1 are the rule rather than the exception. The magnetic slip coupling and a-c motor are inherently constant torque machines. When applied to a constant horsepower load, the coupling size and drive motor size is determined by the torque required at minimum speed. This could mean that a 100-hp winding reel drive with a reel calling for a 4 to 1 coil build-up would require a 400-hp coupling and a-c driving motor.

3. Tension range requirements—In some mills tension requirements may vary over a range of 10 to 1. Accurate tension control is required throughout this range. This could be a definite factor in the selection of the proper winding reel drive. I would like to ask the author therefore, just what the operating limits of the coupling drive are in this respect?

4. Stalled tension—When the winding reel drive is stalled, the output voltage of the tachometer generator mounted on the winder drive as well as the tachometer generator used to indicate strip process speed are both essentially zero. Just what means are used to regulate the proper stalled tension, and does the transition from stalled tension to running tension provide smooth continuous regulation without any disturbances to the system?

These are a few of the factors which should be considered in selection of the proper reel drive. It is hoped that the author will comment upon the field of application of the coupling drive so that we can properly evaluate its usefulness to the steel industry.

P. R. Gravenstreter: Admittedly, a loss in the form of warm water, is to be dissipated. One cannot get something for nothing. Unfortunately, the losses do cost money and must be considered in the application of any equipment.

There is no intent, expressed or implied, to replace the d-c adjustable-voltage system. Many factors must be considered. Adequate tension range and coil diameter compensation must be resolved to the purchaser's satisfaction. A range of 8 to 1 or 9 to 1 is probably the outside permissible limit of tension range and coil diameter variations. This is not as great a range of permissible variation as with adjustable voltage, but neither is the price of this system anywhere as large as the d-c system.

In conclusion, it is to be said here is a workable system with certain characteristics. If the system with its limitations meet the required specifications, it should receive consideration. ▲

1959 AISE

SPRING CONFERENCE

Auspices of Rolling Mill Committee

April 27, 28, 29

Hotel Statler
Buffalo, N. Y.

The President's Message

Last year we again witnessed many technical developments. The individual engineer hardly had the time to acquaint himself with all of them, let alone appraise them properly. The Association of Iron and Steel Engineers, devoted to the advancement of the technical phases of the iron and steel industry, has helped its members immeasurably to stay abreast of developments and to evaluate those new methods and processes which showed promise for economic gain in our industry.

This year no doubt will yield new developments just as profusely as last year. We know right now that the St. Lawrence Seaway will be opened and that jet aircraft will go commercial. This will make our world a good bit smaller and thus will increase our horizon. Far-away neighbors seemingly will move closer, and it will become a challenge to all of us how to deal with the new problems arising from this type of development.

Now more than ever, it seems important that we employ teamwork to turn today's problems into opportunities of tomorrow, that we avoid duplication of efforts and pool our technical and operational know-how.

Let us work together, let us learn from each other, and let us grow on each other and with each other by contributing in an ever increasing measure to the activities of the AISE.

EMIL KERN

President, AISE

Emil Kern

President 1959

Association of Iron and Steel Engineers

EMIL KERN was born in Stuttgart, Germany, in 1901 and graduated from the Technical Institute of Stuttgart with the degree of Dipl Ingr in mechanical engineering in 1925. As one requirement for his diploma, he spent a year obtaining practical experience with the Maschine Factory Esslingen in Stuttgart. In 1925 Mr. Kern joined M.A.N. (Maschine Factory Augsburg-Nuremberg) at the Nuremberg plant as a computing engineer in the steam turbine department. At the end of that year he was selected as one of 200 engineers being sent to the United States under an exchange plan for two years to study industrial conditions in this country. He was assigned with a small group to the Mesta Machine Co. where he worked two years starting in the shop as a laborer and fitter. In August, 1928 he returned to Germany, going back to work with M.A.N. In April, 1930 he emigrated to the United States and started to work again at Mesta as a designer of mill machinery. He was in charge of proposal engineering when he left in 1945 to go with the Reynolds Metals Co. as chief mechanical engineer. In 1946, he came back to Pittsburgh as chief engineer of the Allegheny Ludlum Steel Corp. and was promoted to vice president in charge of engineering in May, 1949.

AISE Officers and Directors, 1959

S. C. READ
First Vice President

S. C. READ attended Purdue University and the University of Michigan. He graduated from the University of Michigan with a degree in mechanical engineering, and later received a master's degree in metallurgical engineering at the Carnegie Institute of Technology. He completed machinist apprentice training with the Pennsylvania Railroad and was advanced to assistant master mechanic in 1920.

In 1924 he started to work for Jones & Laughlin Steel Corp., Pittsburgh, Pa., as assistant superintendent—power department at the South Side works. He became master mechanic—rolling mills, Pittsburgh works in 1938. He was appointed superintendent of blooming department and rolling mills, Pittsburgh works in March 1946. In November, 1947 he moved to the general offices as manager of maintenance, advancing later to manager of construction and maintenance, and finally to present position of director of construction and maintenance in September, 1950.

C. E. PRITCHARD
Second Vice President

C. E. PRITCHARD was born in Pittsburgh, Pa., and was graduated from Carnegie Institute of Technology in 1932. He first worked for the Atlantic Refining Co. where he stayed until 1937, at which time he entered the steel industry. He then became employed in mill maintenance at the Warren district of Republic Steel Corp., with later appointment as district lubrication engineer. In 1941 he was promoted to chief lubrication engineer of all Republic Steel's operations with headquarters in the general office in Cleveland. In 1951, he joined the Alan Wood Steel Co., serving as superintendent of finishing mills. The following year he was promoted to superintendent of mills, including all rolling mills and finishing operations. In 1957 he was appointed to the position of general superintendent of mills, the position he now holds.

H. L. Jenter
Treasurer

HARRY L. JENTER was born in Trenton, N. J., in 1901. He joined the American Steel & Wire Division's Trenton works in 1917 as a draftsman, and for the next few years alternately worked for the division and attended college. In 1926 he was graduated from Syracuse University with a degree in mechanical engineering and transferred to the Cleveland office. In 1928 he was made assistant foreman at the Newburgh Wire Works. Mr. Jenter was transferred to the Cuyahoga works cold roll strip department in 1932, and in 1934 was made general foreman. He became assistant superintendent of the works in 1935, general superintendent in 1939, and in 1942 transferred to the headquarters office as assistant to the vice president of operations. He resumed the post of general superintendent of Cuyahoga works a year later, was made chief engineer in 1950, assistant district manager in 1952, and manager of operations—Cleveland District, American Steel & Wire Division, U. S. Steel Corp., in 1953. In 1956 he became vice president of operations.

C. W. BRUCE
Secretary

C. W. BRUCE was graduated from Case Institute of Technology in mechanical engineering in 1933. He started in the steel business in the blooming mill at the Corrigan-McKinney Steel Co. and in 1934 transferred to the combustion department. After the merger with Republic Steel Corp. in 1935 he continued in the combustion department until 1942, at which time he was transferred to the Chicago district as combustion engineer. In 1947 he was made assistant chief engineer of the Chicago district and in 1951 chief engineer. In January, 1958 he was transferred to the General Office as chief engineer of steel plants for Republic Steel Corp.

H. R. KNUST
Director-at-Large

H. RUSSELL KNUST was born in Jessup, Md., in 1918. He was graduated from the University of Maryland with a Bachelor of Science degree in mechanical engineering in June, 1940, when he entered the "loop" course of the Bethlehem Steel Co. In August, 1940, he was transferred to the Sparrows Point plant, mechanical department. At this plant he progressed from field foreman to assistant master mechanic of mills, to supervisor of maintenance, to assistant superintendent of mechanical department, superintendent of mechanical department, to assistant to general manager, and in 1956 he was appointed assistant general manager, the position he now holds. He is a member of the AISI, ASME and past president of the Engineers Club of Sparrows Point.

M. B. ANTRIM
Director

M. B. ANTRIM, a native of Pennsylvania, received an electrical engineering degree from Rensselaer Polytechnic Institute in 1939. He was first employed by Westinghouse Electric Corp. in Philadelphia before joining Lukens Steel Co. as assistant to the superintendent, electric, in 1941. At Lukens he has progressed successively from senior technical assistant, electrical engineer assistant superintendent and superintendent of the electrical department. In 1953 he was appointed

to assistant manager of the maintenance and construction division, which position he now holds.

G. I. BOTTCHER
Director

GEORGE I. BOTTCHER was born and reared in Montana. He studied at Montana State and transferred to Cornell where he received his degree in architecture in 1932, and a master of science degree in 1933. He worked in the construction and building field from 1933 to 1942; joining Allegheny Ludlum Steel Corp. in 1940 as a draftsman in the general engineering division. He became assistant chief engineer in 1946, and in 1950 became chief engineer; in 1957 he was made manager of design and construction which position he now holds.

M. J. BURGER
Director

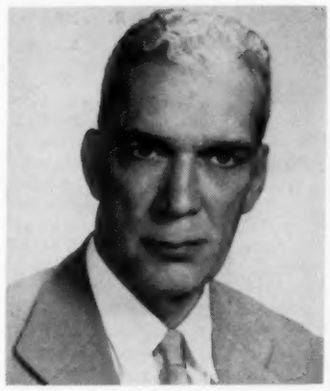
M. J. BURGER was born in McKeesport, Pa., in 1915. He graduated from Georgia Institute of Technology with a bachelor of science degree in electrical engineering in 1940. He then joined the United States Steel Corp. as draftsman in the Ordnance Engineering Division, Pittsburgh, transferring to Mingo Junction as electrical construction supervisor. In 1943 he was transferred to the Youngstown District as design engineer and was promoted to assistant electrical engineer in 1947. In 1948 he was appointed to his present position as general supervisor, electrical engineering.

A. E. CICHELLI
Director

A. E. CICHELLI was born in Baltimore, Md. He attended Loyola College, receiving in 1936 a bachelor of science degree in chemistry, and John Hopkins University receiving, in 1938 a bachelor of science degree in chemical engineering, and in 1943 a bachelor of science in mechanical engineering. In 1938 he entered the employ of Bethlehem Steel Company, Sparrows Point, as an analyst in the metallurgical department. In 1939 he transferred to the mechanical department, serving as a foreman on the general mechanical department staff, specializing in oxyacetylene processes, lubrication and miscellaneous maintenance. In 1956 he was appointed to the position of lubrication engineer at Sparrows Point, and in 1951 was transferred to his present position in the general offices in Bethlehem as lubrication engineer.

G. R. CLARKE
Director

G. R. CLARKE started work in 1916 at the Alton plant of the Laclede Steel Co. He became blooming mill superintendent in 1923, and later became superintendent of the 10-in. mill, 8-in. mill, and billet yard. In 1945 he became plant superintendent of the Alton plant. In 1951 he was made assistant general manager of both the Alton and Madison plants, and since December 1954 has served as general superintendent of the Laclede Steel Co.



F. M. DARNER
Director

FREDERIC M. DARNER, a native of Ohio, was graduated from Case Institute of Technology in 1922 with a bachelor of science degree in mechanical engineering. He entered the steel industry that year with the Armco Steel Co. at Zanesville, Ohio, as testing engineer and liaison for the Middletown Engineering Department in the Zanesville plant. In 1923 he moved to Armco, Middletown, Ohio, as a member of the sales development group. In 1926 he entered the engineering department of the Erie Steam Shovel Co., Erie, Pa. In 1927 he was employed by Erie Malleable Iron Co. as plant engineer in charge of all service shops and equipment. In 1933 he entered the employ of the Republic Steel Corp., steel and tubes, Cleveland plant, as plant engineer, in 1934 became chief engineer of this division. In 1939 he was promoted to assistant chief engineer of the corporation and in 1942 he was named chief engineer, manufacturing divisions. He now serves in this capacity as well as being appointed in 1950, upon organization of Reserve Mining Co. for taconite beneficiation, as supervising engineer, in charge of design engineering. In 1958, he also was made chairman, engineering coordinating committee, Republic Steel Corp.

R. L. FELLERS
Director

ROBERT L. FELLERS was born in Cincinnati, Ohio, and was graduated from the University of Cincinnati with a degree of electrical engineering. Between 1933 and 1943 he was employed by the Andrews Steel Co. as maintenance foreman, assistant electrical superintendent and chief electrical engineer. He then worked for the Tennessee Eastman Corp. at Oak Ridge, Tenn., for three years, leaving to join the National Tube Div. of the United States Steel Corp. as a general supervisor of design engineers. He transferred to the Tennessee Coal and Iron Div. in 1954 as chief development engineer. He is now supervisor of specifications and contracts.

F. R. FIELDING
Director

F. R. FIELDING was born in Sharon, Pa., and was graduated from Penn State in mechanical engineering in 1916. He went to work at the Donora Steel Works of American Steel and Wire Co. after graduation, working in various departments until 1921 when he was employed in the engineering department at the Donner Steel Co. in Buffalo, N. Y. This company later combined with others in the forming of Republic Steel Corp. After serving as field engineer in this plant, he was appointed assistant chief engineer in 1945, and district chief engineer in 1952. He now serves in that capacity.

RUBEN FINKELSTEIN
Director

RUBEN FINKELSTEIN was born in 1901 in Los Angeles, Calif. He was educated in local schools. He entered the scrap business with his father in 1916. This business today is Finkelstein Supply Corp. and Ruben Finkelstein is now a vice president. In 1940 the Southwest Steel Rolling Mills was organized. Mr. Finkelstein is also a vice president of this company.

R. E. HARRIS
Director

WALTER E. HARRIS was born in San Francisco, Calif., in 1928. In 1949 he was graduated from the University of California at Berkeley with a B.S. degree in industrial engineering. He began his career with Consolidated Western Steel Div., United States Steel Corp. in August, 1949, at the Berkeley plant, serving as material expeditor in the production department, assistant foreman in the erection department, scheduler in the production planning department, design draftsman, project engineer and plant engineer.

In 1953 he was assigned to the designing and planning of the construction of the Utah pipe mill of Consolidated Western Steel Div., with headquarters in Maywood, Calif. In March, 1955, he moved to Provo, Utah, to assume his new duties as plant engineer of the newly-constructed Utah pipe mill.

W. H. KINNEY
Director

WILLIAM H. KINNEY was graduated from the University of Arizona with a bachelor of science degree in metallurgical engineering 1943. From 1943 to 1947 he was in the United States Army as an armored cavalry officer, serving in Europe. In 1948 he joined the Kaiser Steel Corp. at Fontana, Calif., first as a metallurgical assistant, then metallurgist, and in 1950 he became a metallurgical engineer. From 1956 to the present time he has been assistant to vice president in charge of operations at Oakland, Calif

R. A. KRAUS
Director

ROBERT A. KRAUS, a native of Chicago, obtained bachelor and master degrees in mechanical engineering at the Illinois Institute of Technology. In 1939 he entered the steel industry joining Republic Steel Corp., in Chicago, as a junior mechanical engineer moving up later to an industrial engineer. In 1943 he was appointed lubrication engineer and in this capacity assisted in the construction of the Republic Chicago Defense plant. In 1947 he was named to the position of general mechanical foreman for the Chicago properties. In November, 1950, he was named assistant mechanical superintendent and in July, 1957, appointed to his present position of superintendent mechanical maintenance.

R. A. LAMBERT
Director

R. A. LAMBERT was born in 1907 in Pittsburgh, Pa., and attended school in that area. He attended Carnegie Institute of Technology at night and completed the requirements for a bachelor's degree in mechanical engineering. He also did postgraduate work in heat engineering and advanced mathematics. He entered the steel industry in 1925 through employment in the machine shop at J&L. He left there and joined Crucible Steel Co. as a chemist and then joined Heppenstall Knife & Forge Co. as assistant purchasing agent. In 1929 he returned to J&L, Pittsburgh Works div., serving as shop draftsman, practice engineer, mechanic, etc. In 1936 he was transferred to the fuel department and in 1940 advanced to combustion engineer. In 1945 he became assistant superintendent of steam efficiency and combustion department. In 1947 he became superintendent of the department, which position he now holds.

H. A. LONG
Director

HERBERT A. LONG is a native of Pennsylvania and attended public schools in that state. He attended Waynesburg College and studied engineering while working for the Pittsburgh Steel Co. During his period of employment with Pittsburgh Steel, he served as inspector, then transferred to engineering and held positions as blue print clerk, draftsman, chief draftsman, and chief engineer. In 1957 he became general manager of operations and now serves in that capacity.

N. C. MICHELS
Director

N. C. MICHELS graduated from Purdue University with a degree in electrical engineering in 1936 and later did graduate work at Loyola University and M.I.T. He entered the employ of United States Steel Corp. in Pittsburgh in 1941 in the engineering department. He left the service of U.S. Steel in 1947, returning to its engineering department in 1950. He was transferred to the Tennessee Coal & Iron Division of U.S. Steel in December, 1954, and was elected vice president—engineering of that division on September 1, 1955, which position he now holds.

LOUIS MOSES
Director

LOUIS MOSES started as a messenger boy with Cambria Steel Co. in Johnstown, Pa., in 1899. Here he received training as machinist and draftsman in the maintenance and construction department. From 1908 his main interests embraced roll design and roll maintenance for the prime producers, semi-finished mills, plate mills, and the rolling of the smallest to the largest sections. When Cambria was acquired by Bethlehem Steel Co. in 1923 he remained in the organization and was transferred to the Sparrows Point plant the same year, as superintendent of the roll department. In this capacity he took part in the development of the various mills at the Sparrows Point plant. Some years later he was also placed in charge of rail mill operations. In 1952 he was transferred to the construction engineering department of Bethlehem Steel Co., at Bethlehem where he still follows his specialty.

A. D. SHATTUCK
Director

A. D. SHATTUCK, a native of Ohio, entered the steel industry in 1933, being employed at the Central Alloy District of Republic Steel Corp. at Massillon as heater helper at the coke plant. He joined the Great Lakes Steel Corp. at Ecorse in 1938, as a coke oven battery foreman, advancing to general turn foreman, to assistant superintendent and in May, 1951, was appointed superintendent of coke plant, the position he now holds.

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Immersion Thermocouple Practice

by H. V. Schubert,
Fuel Engineer,
Seattle Plant,
Bethlehem Pacific Coast Steel Corp.,
Seattle, Wash.

. . . . reliable readings are obtained when sound operating and maintenance techniques are practiced . . . .

THIS paper is concerned with the basic design, construction, application and maintenance of the bath thermocouple, one of the modern tools of the steel industry. Although proper application and adequate instrumentation are recognized as important factors, considerable emphasis is placed upon thermocouple maintenance. A daily record of thermocouple performance that includes a classification key system of the type of reading obtained and methods for checking the accuracy of the thermocouple and the condition of its components are discussed.

The immersion thermocouple has, in recent years, become an important tool in the steel industry. Experience has shown that the reliability of the thermocouple is a function of proper application and interpretation and adequate maintenance.

Some years ago work was started on the design of an immersion thermocouple for use in our Seattle plant. As the result of experimentation and the experience of others a thermocouple unit was gradually developed. It has become a part of our operation.

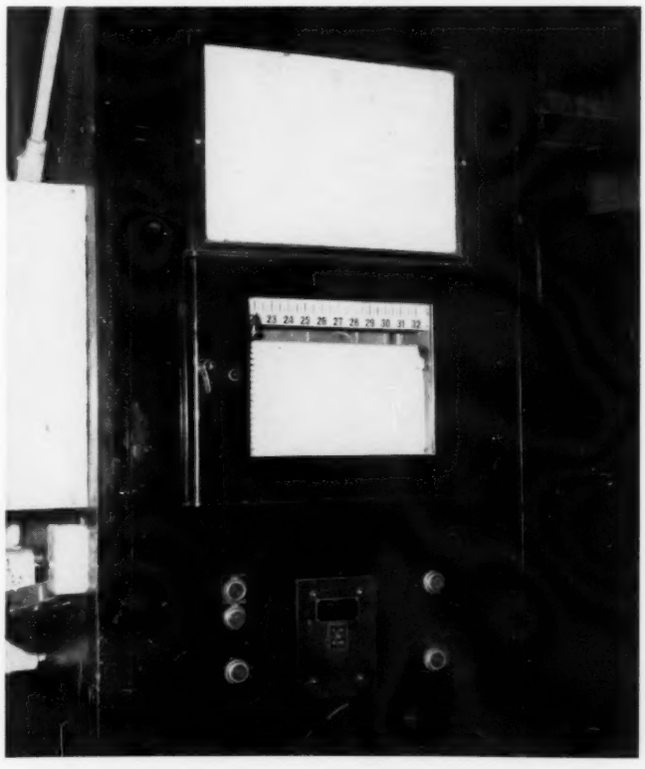
The bath temperature instrument, the immersion thermocouple unit (its application, interpretation), temperature curve analysis, data sheet, maintenance, associated equipment, calibration check, and problems will be covered.

BATH TEMPERATURE INSTRUMENT

The bath temperature instrument shown in Figure 1 is an electronic, indicating, recording strip chart potentiometer which makes a single record with a two-second pen speed. It has push button standardization, range 2200 to 3200 F for type R thermocouple, chart speed set for 120 in. per hr, and a back-set switch that actuates the chart drive at 2400 F. A small timer which is activated by the chart drive back-set switch has been installed in the instrument. This timer, shown in Figure 2, is preset for a maximum immersion time of 30 sec after which it initiates a signal for withdrawal of the thermocouple. The instrument is equipped with an accessory that provides a source of external voltage to drive the instrument up-scale for energizing the chart drive circuit and allowing push-button standardization.

The instrument is wired to five service outlets, one at each furnace control panel. Each is complete with a detachable, flexible thermocouple extension lead wire fitted with a thermocouple connector. The signal system consists of signal horns controlled at the instrument by either a manual pushbutton or the automatic

Figure 1 — The bath temperature instrument is an electronic recording chart potentiometer with a recording temperature range of 2200 to 3200 F. It is wired to five service outlets to which the thermocouples are attached.



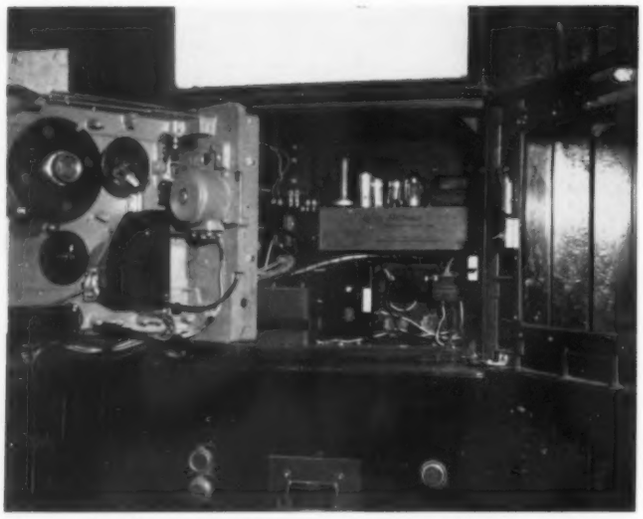


Figure 2 — In the instrument is a protective device, a timer, which sounds a signal at a predetermined time after the thermocouple has been immersed to remind the furnace helper to remove the thermocouple from the bath lest it be damaged. The timer is activated by the chart drive back-set switch.

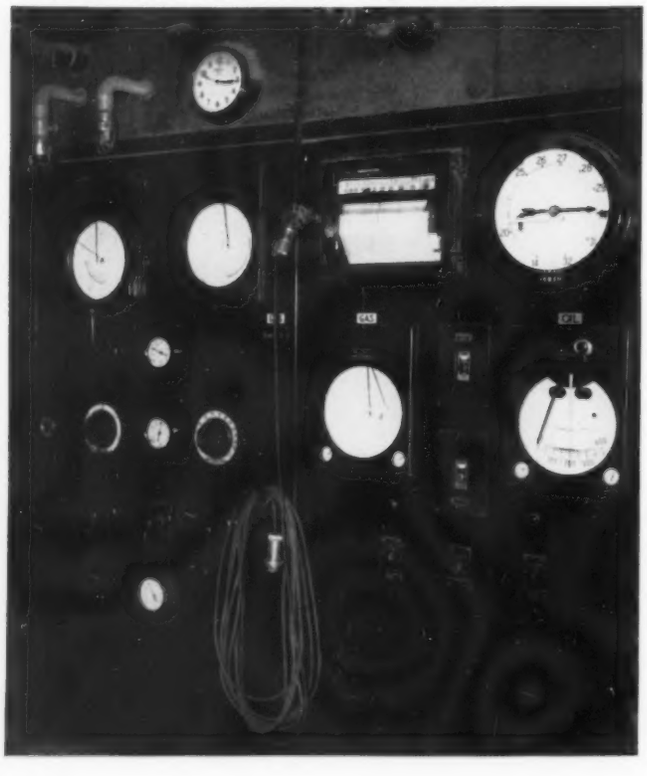
timer and located at each plug-in-station. One is shown in Figure 3.

THE THERMOCOUPLE UNIT

The thermocouple unit consists of the following parts shown in Figure 4:

a. Standard ¾-in. black pipe, 9 ft-2 in. long with pipe threads on both ends.
b. Type C condulet.
c. Connector base.
d. Turned pipe bushings.

Figure 3 — Each thermocouple plug-in-station at the furnace control panels has an attachable, flexible thermocouple extension lead wire and a signal horn.



1. One screwed-on-the-end of the ¾-in. pipe.
2. One bored to slip over the ¾-in. pipe.

e. Compression spring for unit expansion.
f. Graphite parts.
1. 1½-in. pipe.
2. Bushings for graphite pipe joints.
3. Cap.
4. Plug.

g. 18-in. type R thermocouple (platinum-platinum rhodium 13 per cent).
h. Bare, type SX lead wire, 6 ft long.
i. Asbestos covered, type SX lead wire, 2 ft long.
j. Connector.
1. Thermocouple unit.
2. Mechanical (lead wire).

k. Quartz, double bore, clear insulator with 0.025-in. minimum diameter bore and 4 mm maximum outside diameter.
l. Fourteen, double bore, 3-in. ceramic insulator for bare lead wire.
m. Eight-gage, double bore, 3-in. ceramic insulator for covering joint connections.
n. Quartz tube, closed and clear with a 3½-in. long, 4.5 mm inside diameter and 6.5 to 8.0 mm outside diameter.
o. Refractory cement.

The sections of graphite pipe are supported at the joint by a graphite bushing that makes it possible to use short lengths of graphite pipe. The compression spring exerts pressure on the graphite pipe to maintain tight joints and also to allow expansion space for the ¾-in. pipe. A refractory cement is used to secure the graphite cap to the graphite pipe and the quartz tube in the tapered plug. A brush coat of this same refractory cement is applied to the lower 4 ft, or the immersion end of the thermocouple, to give added protection to the thermocouple during immersion.

The thermocouple is oxygen-acetylene welded to the bare lead wire. The bare lead wire is attached to asbestos covered lead wire by a mechanical connector.

SHOP FACILITIES

Shop facilities, some of which are shown in Figure 5, for making and maintaining the thermocouple unit include:

a. Long work table.
b. Oxygen-acetylene welding and cutting equipment.
c. 9-in. metal lathe equipped with dust collector.
d. Pipe cutting and threading tools.
e. Hand tools.
f. Small electric furnace.
g. Portable potentiometer.
h. Null-balance indicator.

Figure 4 — A thermocouple contains these disassembled parts.

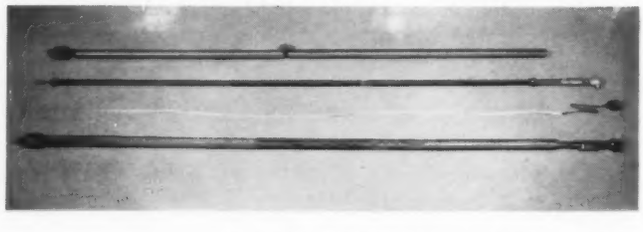


Figure 5 — This equipment, which includes a small electric furnace, portable potentiometer, null-balance indicator, resistance type heating unit, butt welder and a small microscope, is used to maintain the thermocouple unit.

i. Resistance type heating unit.
j. Butt welder.
k. Small microscope.

The operating maintenance work is done by a thermocouple repairman and a meter man who assists in initial fabrication, calibration and major repair.

OPERATING FACILITIES

Operating facilities, shown in Figure 6, include:

a. Hot lay down table.
b. Angle of immersion gage.
c. Make-up stand.
d. Work table.
e. Storage conveyor.
f. Infrared heaters.

See the Appendix for immersion gage, conveyor and heater data.

TAKING A READING

When a reading is to be taken, a furnace helper takes the thermocouple from the storage conveyor to the furnace where the flexible extension lead wire is connected. The melter, at the instrument, checks out the thermocouple circuit with the standardizing accessory which applies a voltage to the circuit. If satisfactory, the instrument will not respond. However, if an open circuit exists, the instrument will respond and drive up sale. The instrument is equipped with only manual standardization and is wired in such a way as to permit standardization only when a thermocouple is not connected. During this process of manual standardization, the instrument is driven up-scale from an external voltage. However, if a good thermocouple was connected to the instrument and an attempt was made to standardize, the external voltage would be shorted out by the completed circuit through the connected thermocouple. Therefore no movement in the instrument would be detected. Conversely, if the thermocouple unit had an open circuit the external voltage would not be shorted out and the instrument would respond and drive up scale. If the circuit is closed, the

Figure 6 — Thermocouple operating facilities include a hot laydown table, immersion gage, make-up stand, work table, and storage conveyor with infrared heaters for drying the refractory cement put on the immersion ends of the thermocouples.

melter signals for the immersion. The furnace helper makes the immersion in the furnace as depicted in Figure 7. The melter observes the recording being made. When the curve has leveled off, he signals for withdrawal of the thermocouple. The thermocouple is then disconnected and taken to the hot lay-down table. Identification of the reading as to time, thermocouple number and heat number is made on the chart beside the curve. The average thermocouple immersion time is 22 sec.

TEMPERATURE CURVE ANALYSIS AND DATA SHEET

In order to obtain all of the information possible from the readings, a detailed study of these temperature curve records was made. The results of these studies

Figure 7 — When a temperature measurement is to be made, the thermocouple, connected to one of the service outlets, is inserted through the furnace door.

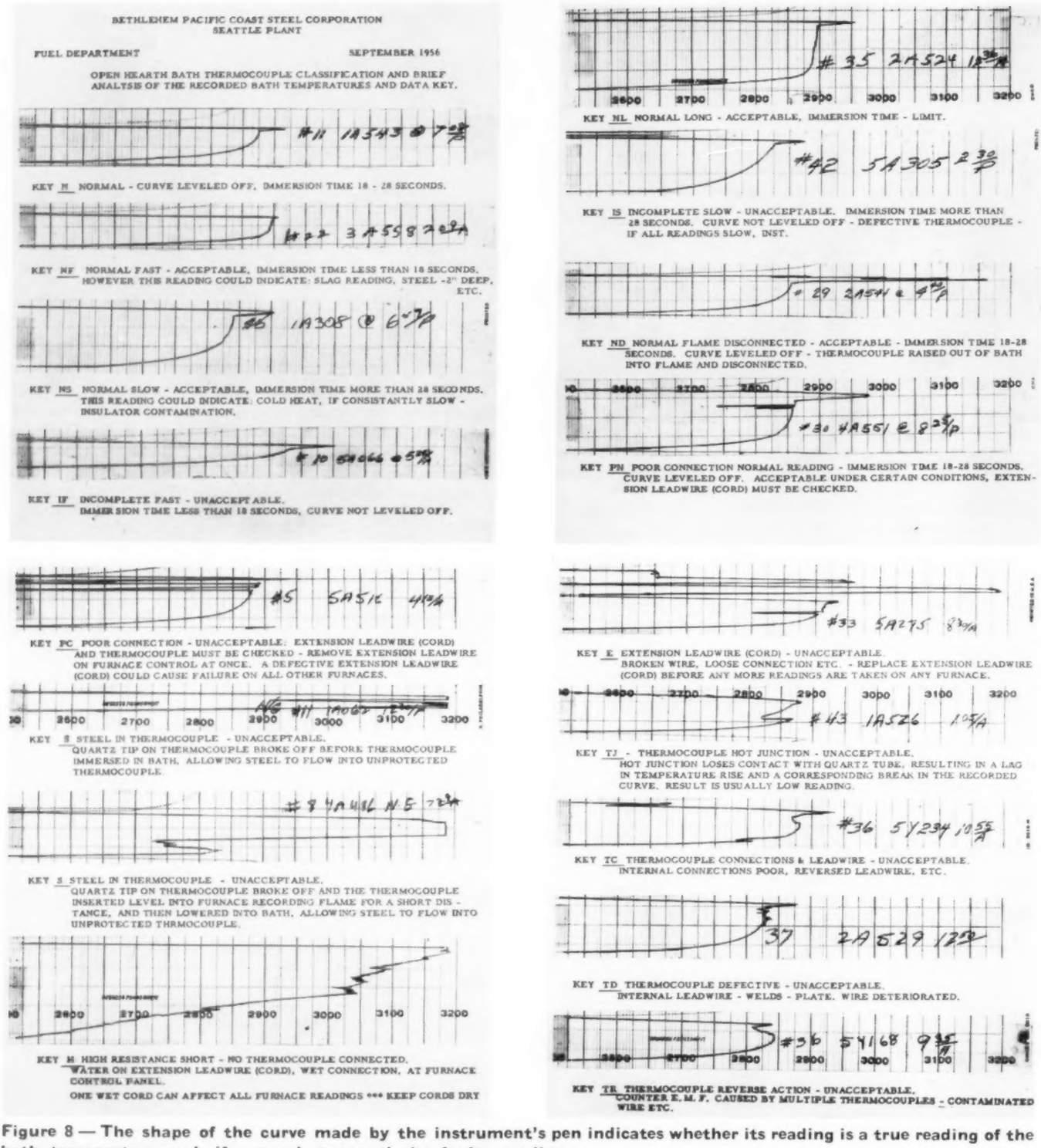

BETHLEHEM PACIFIC COAST STEEL CORPORATION
SEATTLE PLANT
FUEL DEPARTMENT
SEPTEMBER 1956
OPEN HEARTH BATH THERMOCOUPLE CLASSIFICATION AND BRIEF ANALYSIS OF THE RECORDED BATH TEMPERATURES AND DATA KEY.
KEY N NORMAL - CURVE LEVELED OFF. IMMERSION TIME 18 - 28 SECONDS.
KEY NF NORMAL FAST - ACCEPTABLE. IMMERSION TIME LESS THAN 18 SECONDS. HOWEVER THIS READING COULD INDICATE: SLAG READING, STEEL -2" DEEP, ETC.
KEY NS NORMAL SLOW - ACCEPTABLE. IMMERSION TIME MORE THAN 28 SECONDS. THIS READING COULD INDICATE: COLD HEAT, IF CONSISTANTLY SLOW - INSULATOR CONTAMINATION.
KEY IF INCOMPLETE FAST - UNACCEPTABLE. IMMERSION TIME LESS THAN 18 SECONDS, CURVE NOT LEVELED OFF.
KEY NL NORMAL LONG - ACCEPTABLE. IMMERSION TIME - LIMIT.
KEY IS INCOMPLETE SLOW - UNACCEPTABLE. IMMERSION TIME MORE THAN 28 SECONDS. CURVE NOT LEVELED OFF - DEFECTIVE THERMOCOUPLE - IF ALL READINGS SLOW, INST.
KEY ND NORMAL FLAME DISCONNECTED - ACCEPTABLE - IMMERSION TIME 18-28 SECONDS. CURVE LEVELED OFF - THERMOCOUPLE RAISED OUT OF BATH INTO FLAME AND DISCONNECTED.
KEY PN POOR CONNECTION NORMAL READING - IMMERSION TIME 18-28 SECONDS. CURVE LEVELED OFF. ACCEPTABLE UNDER CERTAIN CONDITIONS, EXTENSION LEADWIRE (CORD) MUST BE CHECKED.
KEY PC POOR CONNECTION - UNACCEPTABLE. EXTENSION LEADWIRE (CORD) AND THERMOCOUPLE MUST BE CHECKED - REMOVE EXTENSION LEADWIRE ON FURNACE CONTROL AT ONCE. A DEFECTIVE EXTENSION LEADWIRE (CORD) COULD CAUSE FAILURE ON ALL OTHER FURNACES.
KEY S STEEL IN THERMOCOUPLE - UNACCEPTABLE. QUARTZ TIP ON THERMOCOUPLE BROKE OFF BEFORE THERMOCOUPLE IMMERSED IN BATH, ALLOWING STEEL TO FLOW INTO UNPROTECTED THERMOCOUPLE.
KEY S STEEL IN THERMOCOUPLE - UNACCEPTABLE. QUARTZ TIP ON THERMOCOUPLE BROKE OFF AND THE THERMOCOUPLE INSERTED LEVEL INTO FURNACE RECORDING FLAME FOR A SHORT DISTANCE, AND THEN LOWERED INTO BATH, ALLOWING STEEL TO FLOW INTO UNPROTECTED THRMOCOUPLE.
KEY H HIGH RESISTANCE SHORT - NO THERMOCOUPLE CONNECTED. WATER ON EXTENSION LEADWIRE (CORD), WET CONNECTION, AT FURNACE CONTROL PANEL.
ONE WET CORD CAN AFFECT ALL FURNACE READINGS *** KEEP CORDS DRY
KEY E EXTENSION LEADWIRE (CORD) - UNACCEPTABLE. BROKEN WIRE, LOOSE CONNECTION ETC. - REPLACE EXTENSION LEADWIRE (CORD) BEFORE ANY MORE READINGS ARE TAKEN ON ANY FURNACE.
KEY TJ - THERMOCOUPLE HOT JUNCTION - UNACCEPTABLE. HOT JUNCTION LOSES CONTACT WITH QUARTZ TUBE, RESULTING IN A LAG IN TEMPERATURE RISE AND A CORRESPONDING BREAK IN THE RECORDED CURVE. RESULT IS USUALLY LOW READING.
KEY TC THERMOCOUPLE CONNECTIONS & LEADWIRE - UNACCEPTABLE. INTERNAL CONNECTIONS POOR, REVERSED LEADWIRE, ETC.
KEY TD THERMOCOUPLE DEFECTIVE - UNACCEPTABLE. INTERNAL LEADWIRE - WELDS - PLATE. WIRE DETERIORATED.
KEY TR THERMOCOUPLE REVERSE ACTION - UNACCEPTABLE. COUNTER E. M. F. CAUSED BY MULTIPLE THERMOCOUPLES - CONTAMINATED WIRE ETC.

Figure 8 — The shape of the curve made by the instrument's pen indicates whether its reading is a true reading of the bath temperature and, if not, what caused the faulty reading.

produced a set of temperature curve analyses which were classified by a key.

In the curve analysis of Figure 8 note the information recorded at the right of the curves, which were drawn by the instrument's pen. The first number, such as "# 11," is the thermocouple number; the next number such as "1A543," is the heat number; and the "7:08P" is the time this reading was taken.

INTERPRETATION AND APPLICATION

Of course, the first thing desired from an operating viewpoint, when taking a reading, is the temperature attained by the thermocouple. Here again, close attention is paid to the type of curve drawn by the instrument during the process of immersion. Thus the melter is able to make a fast evaluation of the reading and then apply it to the temperature schedule determined by the Metallurgical Department.

EVALUATION OF THE READING

An evaluation of each reading is made by the thermocouple repairman. He records on the thermocouple data sheet, shown in Figure 9, the following information:

a. Heat number.

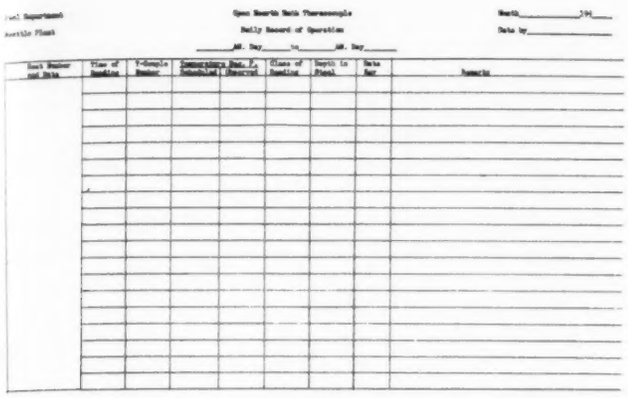


Figure 9 — **A daily record of operation is kept for each thermocouple.**

b. Time of reading.
c. Thermocouple number.
d. Temperature recorded.
e. Class of reading (key from curve analysis).
f. Depth in steel—measured with the angle of immersion gage.
g. Data key.
   1. Slag—slag reading, thermocouple floating.
   2. SL—Steel on thermocouple, light.
   3. SM—Steel on thermocouple, medium.
   4. SH—Steel on thermocouple, heavy.
h. Reading exceeded the critical limit set at 2910 F.

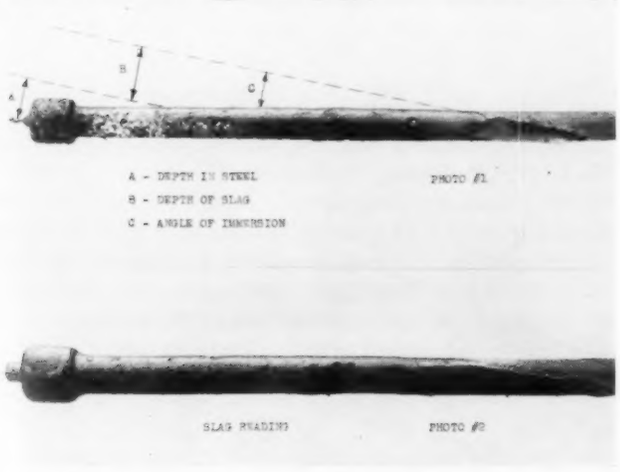
An average of one minute per thermocouple immersion is required to complete the data sheet information.

GENERAL MAINTENANCE

If all items are satisfactory, the thermocouple is made ready for the next reading. The preparation steps are:

a. Measure the depth in the steel bath as shown in Figures 10 and 11 and record. The proper angle setting for the immersion gage is shown in Figure 11 and explained in the Appendix.
b. Remove the slag.
c. Remove the graphite plug containing used quartz tube.
d. Remove the type C condulet cover.

Figure 10 — **The thermocouple is inserted in the bath so that it makes an acute angle with the surface of the bath.**



e. Blow dry compressed air through the thermocouple from the type C condulet to remove any foreign material.
f. Check the hot junction loop for proper size and angle.
g. Insert graphite plug containing new quartz tube.
h. Set thermocouple hot junction loop into a new quartz tube from the type C condulet and replace cover.
i. Check for continuity.
j. Give the immersion end (4 ft) of the thermocouple unit a brush coat of refractory cement and place on the conveyor to dry.

THERMOCOUPLE OPERATING STANDARD AND MAINTENANCE

The limits of acceptance, in all checking procedures, have been set at a total calibration error of less than 0.5 per cent in the working temperature range. In this checking process we strive for perfection because it is here that the operating standard of the thermocouple is maintained. Therefore, major repairs, such as the decontamination process, and the calibration check are very important items in the thermocouple maintenance program.

CHECKING PROCEDURES

The results of each item checked during the examination of a thermocouple, determines the extent of repair. The checking procedure includes:

a. Flame check—This check is considered to be an important one because it is here that parasitic thermocouple action is detected. This check is accomplished by connecting an electronic null-balance indicator across one leg of the thermocouple and adjusting the indicator to zero thus setting up a simple bridge circuit. A flame is then passed the full length of the thermocouple leg while special attention is given to the null-balance indicator noting any deflection from zero. If a small portion of the wire is contaminated, or considerable grain growth is present, the heat from the flame, as it passes this portion of wire, will produce a voltage that will cause an immediate deflection on the null-balance indicator indicating that portion of wire is defective. Further checking is then required to determine if the defective portion of the wire is a result of surface contamination, which can be removed,

Figure 11 — **This is the proper angle setting for the gage when measuring the depth of the temperature reading.**

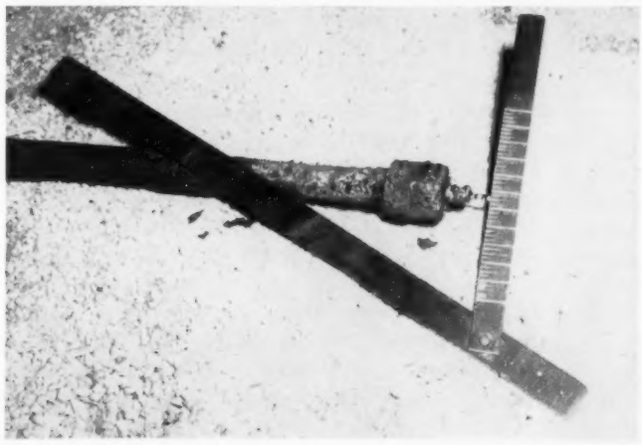


Figure 12 — The thermocouple wire is annealed at 2300 F by a resistance type unit which sends current through the wire. Annealing relieves wire strains and oxidizes surface impurities so that the surface can be cleaned with borax.

or whether the wire is no longer homogeneous. Nonhomogeneity might have resulted from grain growth, volatilization or contamination.

b. Annealing—Annealing is accomplished by placing the thermocouple wire in a jig holder and passing current through it from the output of the resistance type heating unit shown in Figure 12. The temperature of the wire being annealed can be adjusted in two ways: by varying the length of thermocouple wire in the jig holder and by varying the output of the heating unit. In this check one can detect bright spots in the wire that indicate high resistance through a section of wire that is no longer homogeneous. One can also detect whether the wire has been drawn to an under-size gage. The annealing temperature of approximately 2300 F is high enough to relieve wire strains and oxidize surface impurities so that the surface can be cleaned with borax.

The borax treatment is accomplished by applying the borax to one end of the heated thermocouple wire which is inclined at approximately 45 degrees and allowing the molten bead of borax to flow down the wire removing the metallic oxides and the reduced metals on the wire surface. After the thermocouple is annealed and decontaminated, it is handled with tweezers to prevent contamination by human hands.

c. Microscope—Microscopic examination of the thermocouple wire enables the technician to visually verify the results obtained in the flame check and annealing process for it is very easy to detect grain growth and most surface contamination at 75-diam magnification.

d. Butt Welding—All new wire additions and hot-junctions of the thermocouples are done on a butt welder. Through experimentation, microscopic examination, and checking of the welds, the proper welding machine techniques have been developed. The use of these techniques and corresponding settings enables us to produce a weld of the same quality and mass each time. This is especially important in the hot junction weld and also in the curve analyses because a poor weld will produce a lower voltage. A heavy bead at the hot junction will decrease the sensitivity.

e. Calibration check—After the thermocouple is repaired, it is given a calibration check. The checking equipment consists of the following: small electric furnace with a temperature range of 900 to 1000 F (a description is in the Appendix) and a portable potentiometer with its galvanometer replaced by an electronic null-balance indicator. This enables us to narrow the span and increase the sensitivity so as to increase the accuracy at the lower voltages. The thermocouple under test must check within 3 to 5 F of the standard thermocouple.

An explanation of a standard thermocouple is necessary to answer such questions as: what constitutes a standard thermocouple, and when does it cease to be a standard? However, it is not the intent of the author to go into this phase of the operation. Let it suffice to say that, for calibration, a working standard type R thermocouple, which has been checked in the calibrating furnace against other thermocouples reserved as standards, is used. A periodic recheck is made to insure continued accuracy of the working thermocouple. It is replaced as required.

f. Lead wire—The deterioration of the bare lead wire follows a progressive pattern dependent upon the length of time and the greatest degree of temperature reached during the immersions. Close inspection of a bend made in the lead wire reveals its hardness. However, the homogeneity of the wire may be determined by the flame check (Item A of checking procedures) using the lead wire instead of the thermocouple wire.

g. Insulators—After a period of time the ceramic two-hole insulators, which are used the full length of the bare copper lead wire, become discolored. Chemical analysis has shown this to be a result of carbonization of the wire varnish, free carbon and other oxides within the protecting tube of the thermocouple. This carbonization actually impregnates the ceramic insulator, especially on the ends, and eventually causes a high resistance short in the extension lead wire which dissipates the thermocouple voltage.

This condition can, with experience, be detected by visual inspection. However, for a positive check a simple device consisting of two 14-gage brass wires mounted parallel to fit the two-hole insulator was made. These wires are connected in series with 1½ volt size D-cell, a resistor and a millivolt meter. The insulator is slipped over the brass wires; and if the insulator is carbonized enough to complete the circuit, they are discarded. Attempts have been made to reclaim the insulators by treating them chemically and refiring them in a small furnace to dissolve and burn out their carbonization. However, the results were not satisfactory. The quartz insulator is very satisfactory. Its physical properties and its chemical inertness make it an ideal insulator.

PROBLEMS AND CAUSES

Up to now the normal procedure has been described. We realize, however, that many things can happen to a thermocouple to change the desired results. Improper handling of the thermocouple can account for heavy thermocouple maintenance costs and inconsistent results. The term "improper handling" means the misuse of the thermocouple in taking a reading. Some examples of misuses and their corrective measures are as follows:

a. Broken quartz tube—Steel inside thermocouple protecting tube. Corrective measure—Care in handling.

b. Graphite damage—Broken tube, lost or broken cap. Corrective measure—Care in handling before and after reading is taken.

c. Slag reading or buried reading—Thermocouple floating on the steel or immersed too deep in the bath. Corrective measure—Observed the angle of immersion. The uniform depth of immersion (4 to 6 in. in steel) is a requirement for consistent results.

d. Steel coated thermocouple—Although it is recognized that a thermocouple could be coated with steel from a cold heat, recorded data and chemical analysis have shown some of the steel coatings to be exceptionally high in silica. Corrective measure—Thermocouple readings *should not* be taken immediately after additions are made. Adequate time should be allowed for the addition to work through the metal and the bath temperature to permit as much stabilization as possible.

Items of general maintenance which can cause inconsistent results from the thermocouple are:

a. Moisture inside the thermocouple and/or a wet extension lead wire connection will result in a low reading or a high resistance short that dissipates the thermocouple voltage. Corrective measures—Use thermocouples in proper sequence from storage conveyor to insure a thermocouple that is thoroughly dried. Keep extension lead wire off the floor and dry.

b. The hot junction of the thermocouple is pulled back in the quartz tube or twisted. Corrective measure—Close attention to the adjustment of the hot junction in the new quartz tube is required to bend the hot junction loop at approximately 45 degrees so that the hot junction rides the inside wall of the quartz tube. The hot junction loop of the thermocouple is very important. It cannot be twisted or jammed back along the double-bore insulator, or a short circuit of thermocouple voltage will result. It must have ¼ in. plus of bare wire to hold the quartz insulator back. Its loop, which fits inside the quartz tube, must not bind nor allow the hot junction, which must be in the center of the loop, to slide back. Thus contact with the quartz tube is maintained as expansion of the thermocouple unit takes place during immersion.

The items listed above are comparatively simple. However, ignoring anyone of them can result in temperature reading errors of 50 F or more.

Our experience has convinced us that after a thermocouple has exceeded the temperature of 2925 F, it is no longer stable or reliable. We have found that a platinum–platinum rhodium 13 per cent thermocouple on subsequent readings will be on the low side. This high temperature causes volatilization of the rhodium from the platinum. This changes the characteristic of the metal and lowers the voltage for a given temperature. It has also been determined that the rate of change at elevated temperatures depends upon two things: the time and the amount of previous cold working. The amount of cold working any given thermocouple has had is very difficult to determine.

We have set our operating critical temperature at 2910 F. Our investigation has revealed that a working thermocouple, which has had some cold working and has been at elevated temperatures possibly as high as 2900 F, will upon being exposed to a temperature of 2910 F or above cause enough volatilization of the rhodium to change the wire characteristic and subsequently give low readings. In our operation all thermocouples recording a temperature of 2910 F or over are suspected, and are accordingly removed from production for a complete check. It is also important to note that when the characteristic of the metal is changed, annealing or decontamination treatment serves no useful purpose.

SUMMARY

Experience has shown that, through the use of temperature curve analyses and outlined checking procedures, it is possible to maintain an acceptable operating standard for the thermocouple thus making it a valuable shop tool. It is a well known fact that the best instrumentation for temperature detection are no better than their sensing elements. Therefore, proper application and interpretation and adequate maintenance are the key factors in immersion thermocouple practice.

APPENDIX

Thermocouple conveyor—The conveyor consists of a steel frame supporting two carrier, roller-chain belts driven by a 1-hp reversible gear motor through a reduction gear to the drive sprockets. Foot control switches are mounted at each end to facilitate placement of thermocouples after make-up and accessibility at the discharge end. This type of conveyor serves as a thermocouple storage and drying rack, and it insures rotation so that all thermocouples are used.

The basic dimensions of the conveyor are: length—18 ft, width—6 ft and height—36 in.

Depth of immersion gage—The immersion gage consists of two pieces of 2 x 1/16-in. flat steel, one piece 18 in. long marked off in inches from the hinge point and the other 36 in. long. After the immersion, the gage is placed on the thermocouple with the 36-in. leg held parallel to the slag line and the 18-in. leg perpendicular to the quartz tip of the thermocouple. This enables the repairmen to read the depth of immersion on the gage where it contacts the quartz tip (Figure 11).

Infrared heaters—The two standard 7-ft long industrial type radiant heaters are 3600 w each. The two standard 3-ft long industrial type radiant heaters are 1800 w each.

As shown in Figure 6, these heaters are installed above and below the thermocouple-immersion-end side of the conveyor, so an area of approximately 10 ft is had.

Calibration furnace—Its basic dimensions are 9 x 9 x 9 in. The insulating brick on all sides are held in place by small angle tied together by rods. The heating element is a sheath, tubular type and is rated 800 w. The heating element was formed into a 3-in. inside diam coil having three convolutions. It was suspended in the center of the insulated bricks. Molten aluminum was then poured around the element. After cooling three holes were drilled on 1 3/8-in. centers around the center point, and quartz tubes were inserted in them to their full depth. The furnace is manually controlled. A thermocouple is used in one hole to constantly measure the furnace temperature. This leaves one hole for the working standard thermocouple and one hole for the thermocouple under test. ▲

CURRENT DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, February 23, 1959—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Electric Overhead Traveling Crane Maintenance." A Symposium. Led by A. G. Henry, Superintendent of Maintenance, Fairfield Tin Mill, Tennessee Coal & Iron Div., United States Steel Corp., Fairfield, Ala. Three-speaker panel.

Thomas Jefferson Hotel, Birmingham, Ala.

BUFFALO SECTION

Tuesday, February 10, 1959—Dinner 6:30 P.M., Meeting 8:00 P.M.

"Oxygen in Steelmaking," by Jack H. Zimmerman, Manager of Gas Processes, Linde Co., Div. of Union Carbide Corp., New York, N. Y.

Sheraton Hotel, 715 Delaware Avenue, Buffalo, N. Y.

CANTON SECTION

Monday, February 16, 1959—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

Panel Discussion: "Crane Runway Design and Maintenance"

Mergus Restaurant, Canton, Ohio

CHICAGO SECTION

Tuesday, February 2, 1959—Dinner 6:30 P.M., Meeting 7:30 P.M.

"Maintenance Symposium"

"Bearing Maintenance," by R. Kraus, Superintendent, Mechanical Maintenance, Republic Steel Corp., Chicago, Ill.

"Reduction of Maintenance through Modern Lubricants," by J. Wycoff, Youngstown Sheet and Tube Co., East Chicago, Ind.

"Mechanical Seal Maintenance," by C. E. Schmidt, Crane Packing Co., Morton Grove, Ill.

Phil Smidt's Restaurant, 1205 North Calumet Avenue, Hammond, Ind.

CLEVELAND SECTION

Tuesday, February 24, 1959—Dinner 6:30 P.M., Meeting 7:45 P.M.

"Atomic Power in the World Today," by Elmer L. Lindseth, President The Cleveland Electric Illuminating Co., Cleveland, Ohio

Cleveland Engineering & Scientific Center, 3100 Chester Avenue, Cleveland, Ohio

DETROIT SECTION

Wednesday, February 11, 1959—Dinner 6:30 P.M., Meeting 8:00 P.M.

The Detroit Edison Company Night

"New Techniques for Accurate Gage Control—Hot Strip Mills," by H. N. Snively, General Electric Co., Schenectady, N. Y. and R. J. Moran, General Electric Co., Detroit, Mich.

Movie.

Dinner—Cafeteria, General Office Building

Meeting—Sales Auditorium, Service Building, The Detroit Edison Co., Detroit, Mich.

LOS ANGELES SECTION

Data not available

PHILADELPHIA SECTION

Saturday, February 7, 1959—Dinner 6:00 P.M., Meeting 7:00 P.M.

"Modernization of the 160-in. Plate Mill at Sparrows Point," by J. C. Schaake, Chief Draftsman, Engineering Dept., Bethlehem Steel Co., Sparrows Point, Md.

"The Electrical Features of the 160-in. Plate Mill," by T. Massey, Assistant General Foreman, Electrical Dept., Sheet and Tin Mills, Bethlehem Steel Co., Sparrows Point, Md.

Engineers Club, 1317 Spruce Street, Philadelphia, Pa.

PITTSBURGH SECTION

Monday, February 16, 1959—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

Crane Symposium

"Experience with Crane Bridge Drives without Line Shafts," by Wm. Boyd, Senior Electrical Engineer, Head of Smelting Section, Aluminum Company of America, Pittsburgh, Pa.

"Dual Capacity Hoist for Overhead Electrical Traveling Cranes," by Donald Schaper, Sales Engineer, The Morgan Engineering Co., Alliance, Ohio

"Possibilities of A-C Cranes for Steel Mills," by H. A. Zollinger, Material Handling Engineer, Industrial Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

University Club, University Place, Pittsburgh, Pa.

St. LOUIS SECTION

Wednesday, February 25, 1959—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Roll Grinders," by Karl G. Keck, Engineering Service Dept., Cincinnati Milling and Grinding Machines, Inc., Cincinnati, Ohio

Elks Club, Granite City, Ill.

SAN FRANCISCO SECTION

No February Meeting.

UTAH SECTION

Utah District

Monday, February 9, 1959—Social Hour 6:30 P.M., Dinner 7:30 P.M., Meeting 8:30 P.M.

Details not available

Grandview Cafe, Provo, Utah

Pueblo District

Tuesday, February 17, 1959—Social Hour 6:30 P.M., Dinner 7:30 P.M., Meeting 8:30 P.M.

"Conditioning of Steel," by H. Hartman, Assistant Area Superintendent, Quality Control, and L. Humphrey, Foreman, Conditioning Dept., Rolling Mills, the Colorado Fuel and Iron Corp., Pueblo, Colo.

Minnequa University Club, Pueblo, Colo.

YOUNGSTOWN SECTION

Monday, February 23, 1959—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Oxygen Steelmaking," Panel Discussion. Panel headed by R. N. Merk, Chief Engineer, Sharon Steel Co., Sharon, Pa.

Mahoning Country Club, Girard, Ohio

Statistical Computations Increase Production

by Dr. Melvin J. Greaves,
Assistant Chief Engineer,
Arthur G. McKee & Co.,
Cleveland, Ohio

Modern computers make possible statistical production studies whose solutions formerly were impractical because they required a prohibitively high number of man-hours.

THE words "multiple correlation of operational variables" may sound strange to a steel plant operator. However, each time an operator considers several factors in arriving at a decision, he is practicing a form of multiple correlation. As the number of factors which influence a decision increases, the problem becomes more difficult. The ability to evaluate the numerous variable factors affecting a process and to make a high percentage of correct decisions is generally referred to as an art. Frequently the results obtained by practicing the art are lacking in some respects and require improvement. Typical of industrial progress, these arts are gradually disappearing and are steadily being replaced by mechanical devices and automatic controls. The purpose of this paper is to illustrate how such a complex problem can be solved mathematically, both accurately and quickly, by an electronic computer.

Computer equipment, which is generally available, provides a powerful tool for the study and improvement of some of the arts of steelmaking. The processes involved in a by-product coke works, a sinter plant, a blast-furnace plant and an open-hearth shop are all possible applications for multiple correlation. In fact, nearly any physical, chemical or metallurgical process can benefit from a correlation analysis.

Even if such an analysis provides only a slight increase in efficiency, it may reduce the cost of production by a substantial amount. The computer furnishes a systematic means whereby cause and effect may be related more accurately and consistently than when operators are forced to rely upon their intuition.

Considerable research has been devoted to methods for improving the quality and rate of production in the various branches of the iron and steel industry. Laboratory tests as well as plant production records have been used as bases for these studies. Much of this information is virtually useless without means to properly interpret the involved relationships which exist between cause and effect. If a single cause is responsible for each effect, then interpretation is simple and no computer aid is necessary. If, on the other hand, many causes are involved, interpretation is not simple; and mistaken conclusions may result. The problem of determining these complex relationships mathematically is known as "multiple correlation." Multiple correlation is not a new technique, but it is relatively uncommon because of the complexity of its application. To solve a single problem by ordinary procedures might require one man-year, but by means of a computer the same problem can be handled in a relatively short time when a suitable program is available. Programs are the instructions which tell the computer the steps to use in solving a problem. Organizations generally develop their own programs to suit their particular needs. However, many programs are available which may be shared and exchanged by users of computers.

Because a computer works with numbers, it is convient to reduce all of the observed data to a mathematical equation. Selected terms from a power series are useful for this purpose. However, other means might serve equally well. For convenience the variables are separated into groups each containing the smallest possible number of related factors. Functional relationships which have been found useful for multiple correlation of six variables, u, vw, and xzy, are as follows:

$$P = a_0 + a_1u + a_2u^2 + a_3u^3 + a_4u^4 + \ldots + b_0 + b_1v + b_2w + b_3vw + b_4v^2 + b_5w^2 + b_6v^2w + b_7vw^2 + b_8v^3 + b_9w^3 + \ldots + c_0 + c_1x + c_2y + c_3z + c_4xy + c_5yz + c_6zx + c_7x^2 + c_8y^2 + c_9z^2 + c_{10}x^2y + c_{11}y^2z + c_{12}z^2x + c_{13}xy^2 + c_{14}yz^2 + c_{15}zx^2 + c_{16}x^3 + c_{17}y^3 + c_{18}z^3 \ldots$$

In the foregoing equation the variable "u" is considered by itself whereas "v" and "w" are inseparable, and "xyz" is considered collectively.

The object is to derive from the data the best or most plausible results which they are capable of affording. This requires finding values for the unknown coefficients, "a", "b," "c," etc., such that the equation representing the given data may be satisfied as nearly as possible when the number of sets of data is greater than the number of terms in the equation and when the sets of data are not strictly compatible with each other. The sets of data are generally assumed to be uniformly trustworthy. Saying that "the equation is to be satisfied as nearly as possible" means that of all possible sets of values that can be assigned to the coefficients, the most

TABLE I
Sinter Plant Operational Variables

Dependent variables	Independent variables			
Production	**Chemical**	**Physical**	**Equipment**	**Operation**
Quantity	Fuel	Returns	Blending	Management
	Coke	Quality	Proportioning	Ability
Quality	Flue dust	Quantity	Mixing	Incentive
Size			Ignition	
Strength	Basic oxides	Moisture		Supervision
Composition	Lime	Mix	Grate-Fan	Experience
Density	Magnesia	Stack gases	Breaker	Incentive
Surface			Screen	
	Acidic oxides	Temperature		Labor
Cost	Silica	Mix	Cooler	Skill
Labor	Alumina	Wind boxes		Incentive
Materials				
Maintenance	Iron oxides	Feed texture		Continuity
Interest	Ferric	Screen analysis		Delays
Depreciation	Ferrous	Density		Availability

satisfactory is that which renders the sum of the squares of the deviations a minimum, i.e.,

$$d_1^2 + d_2^2 + \ldots + d_i^2 + \ldots$$

is to be a minimum where

$d_i = (P_i - P)$ = the deviation
P = the value given by the equation
P_i = the observed value

The application of this statistical method to the iron and steel industry is illustrated in the following abbreviated study of sinter plant data. For purposes of illustration only, multiple correlation is applied to a sintering operation although it could apply equally well to many other phases of the iron and steel industry. Because no two plants operate under identical conditions and because it is impossible to foresee all the operating variables that may arise, no general equation can be presented.

The principal operating variables which affect sinter production are listed in Table I. On the left are shown various factors used to evaluate production, and on the right some of the factors which influence production. The quantity of production is generally expressed as net tons of product per sq ft of grate area per 24 hr. The quality of the product might be expressed in terms of the screen analysis, strength, chemical composition, bulk density and surface area. The total cost expressed in dollars per ton of product would include the cost of labor, materials, maintenance, power, fuel, utilities, general works expense, interest, taxes and depreciation.

The chemical factors include all sources of fuel and the composition of materials as represented by basic and acidic oxides and by ferrous and ferric iron. In order to simplify, all fuels might be expressed as an equivalent quantity of carbon. The basic oxides include lime, magnesia and, if desired, soda ash and potash. The acidic oxides normally include silica and alumina. For purposes of statistical analysis the influence of the acidic and basic oxides on production might be evaluated in terms of the total quantity of these oxides plus a significant ratio such as the sum of the total base constituents divided by the sum of the total acid constituents or, simply, a lime-silica ratio. The ratio of ferrous iron to total iron can be used to express the degree of oxidation of the iron-bearing constituents.

The physical factors include the quality as well as the quantity of the returns, the amount of moisture measured in the mix or in the stack, the temperature of the mix or in the wind boxes, and the screen analysis and density of the mix. Permeability is deliberately omitted because this important characteristic is governed largely by the other variables which are included in Table I. An alternate approach would be substitute permeability for some of these other variables.

Factors relating to equipment include the effects of the blending and mixing equipment along with other auxiliary equipment and the general arrangement of the plant facilities. These factors are more difficult to evaluate than the physical and chemical variables and require special treatment. The size of the grate can be considered by expressing the quantity of production in tons per sq ft of grate area per 24 hr. The bed depth can be included as a separate factor. The significant description of the fan might involve the performance curve expressed in cfm of effective air per sq ft of grate area. The availability of the equipment can be expressed in terms of the number of delays in a 24 hour period and the per cent of time the equipment is actually in operation.

Last but by no means unimportant are the human factors such as the skill of the operators and incentive plans. Such factors may be even more important than some of the other variables. In one instance it was observed that the rate of production of a plant suddenly increased 10 per cent when the operators were placed under a plan in which their pay depended on the production. Any correlation analysis which fails to take factors such as these into account might be very misleading.

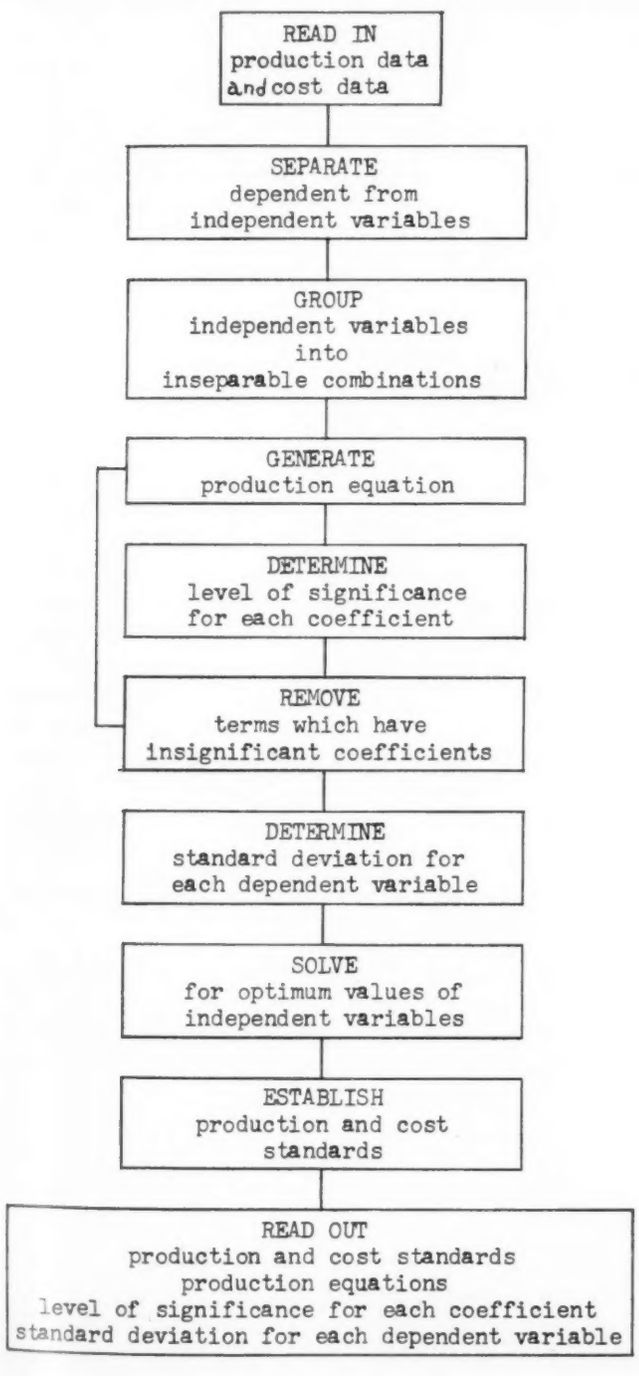
A multiple-correlation program has been designed to analyze data of this nature. The necessary steps are outlined in Figure 1, procedure diagram for multiple correlation. Following the introduction of the production and cost data into the computer, all variables are tested to determine which are independent and which are dependent. Because bed permeability is dependent upon all of the physical factors, this important measure is not independent and is not included in the equation. However, the effect of permeability on production is fully taken into account by consideration of the physical factors.

All pairs and groups of variables which are closely related in their influence on production are then grouped together because they require special treatment in the correlation analysis. The fuel and relative proportions of the acidic and basic oxides fall into this class.

In the next step the quantity, quality and cost of production are each expressed by an algebraic equation containing terms such as "a+bs+cs²" etc. where the "s" term might represent, for example, depth of bed on a sinter machine grate, the "s²" term the depth of bed squared and the "a," "b," and "c" terms represent coefficients determined by the computer.

A statistical test to determine the level of significance is then made for each coefficient determined in the preceding step. Where little or no correlation is found, it is concluded that the variable associated with the coefficient is not significant in influencing production, and such coefficients and associated variables are deleted from the equation. The remaining terms are reprocessed by the computer, and a new set of coefficients is determined in the same manner as before. The above steps are repeated until an equation containing only terms having tested significance and adequately representing the observed data is obtained.

Figure 1 — This block diagram gives the procedure followed in multiple correlation of operational variables.



At this stage in the program, production equations have been generated which express mathematically the dependent variables such as the quantity, quality and/or cost of production in terms of the independent variables which are regularly observed and reported in the production records. The effect of each of these variables on production can be determined by substituting values for the independent variables into the production equation.

The standard deviation for each dependent variable is then determined. This important statistical measure is calculated to provide a reliable guide for properly interpreting the results. The production equations are then used to solve for optimum values for those independent variables which are subject to control by the operators.

By substituting these optimum values plus those of independent variables not under the control of the operator, the production equations which have been generated make possible the prediction of operating results under practically any set of conditions. Production standards may thus be established. Finally all of the results are read out and printed on a suitable form.

The following equation for quantity of production of a sinter plant is typical. Similar equations for quality and cost of production are generated simultaneously if the necessary facts are included with the input data.

PRODUCTION EQUATION FOR A SINTER PLANT

The following equation for production from a particular sinter plant resulted from a multiple correlation of operational variables.

$$P = P_0 + P_{ABC} + P_{RW} + P_X$$

where:

$$P_0 = -12.8$$

$$P_{ABC} = +51A + 5B + 186C + 1290AB + 1140BC + 1590CA - 1920C^2 - 7200AB^2 - 12{,}300BC^2 - 19{,}800CA^2 - 8700A^2B - 9300B^2C - 21{,}600C^2A$$

$$P_{RW} = +66W + 100W^3 - 580{,}000W^6 - 46WR + 19R - 24R^2$$

$$P_X = -0.005X$$

and:

A = silica + alumina
B = lime + magnesia + soda ash + potash
C = carbon
R = returns
W = water
X = delays, number in 24 hr
P = production in net tons per sq ft of grate area per 24 hr

The P_{ABC} portion of this equation representing acid,

base and carbon is a typical application of the triple combination xyz in the functional relationships previously illustrated. The RW terms representing return fines and water illustrate a typical application of the double combination vw.

The production equation applies only within the range of variables that was used in its development. Because of the empirical nature of the equation there is no basis for extending its applications outside this range. This equation is not intended to replace human intelligence and should be considered as a supplement to, rather than as a substitute for, good judgment.

Because no amount of mathematical manipulation can improve inaccurate data, the derived equation can be no better than the information from which it was generated. However, it is believed that, insofar as the observed data adequately describe the operation, this equation constitutes a good summary in a useful form.

Some of the variables, such as the characteristics of the ore, may not be under the control of the operator. Nevertheless, by using this equation the values of the variables which are subject to control can be selected to produce maximum results. For example, the first derivative of the production equation can be taken with respect to any one of the variables, such as the amount of carbon in the mix, and set equal to zero. The solution of the resulting equation is the optimum level for that variable. The optimum level for each of the variables is determined in a similar fashion. By substituting these optimum values in the production equation the maximum theoretical production under the existing conditions may be determined.

Information on all the variables affecting a process is desirable but not necessary. The usefulness of the results will depend in a large measure on the scope as well as the accuracy of the basic information.

Manufacturers of instruments and controls have mastered many of the mechanics of automation and have produced sensing devices to measure many of the changing variables. As such instruments become increasingly available, a suitable means for properly interpreting the data obtained by the new techniques becomes a necessity.

Adapting of the production equation to fit specific plant operations yields the following information, all of which was made possible by a multiple-correlation analysis: (1) the optimum value for each significant operating variable; (2) the effect of each of these variables on production; (3) the expected rate of production when each variable is at its optimum level; and (4) the expected rate of production for any given set of conditions. The value of this information should be readily apparent. ▲

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The Air Pollution Situation Today

with special references to control legislation

by Allen D. Brandt,

Chief Industrial Hygiene Engineer, Bethlehem Steel Co., Bethlehem, Pa.

. . . . each air pollution problem is different . . . . each requires scientific investigation by qualified personnel of the effects of all contaminates to determine which ones are deleterious and how much must be removed to eliminate the annoyance . . . . to be economically sound, each regulatory law should be developed for the area in which it will be enforced . . . .

MUCH might be said about air pollution and about legislation aimed at its control. To insure against over-emphasis of one aspect at the expense of another, the subject matter of this article is subdivided into four convenient parts, namely, (1) what problems does air pollution create, in general; (2) what are the more significant contaminant sources in the steel industry; (3) a suggested sound philosophy to guide regulations; and (4) what is happening in the field of air pollution control legislation.

WHAT PROBLEMS DOES AIR POLUTION CREATE, IN GENERAL

Air pollutants can affect the health or well being of humans, they can injure animals, they can harm personal or real property, they can injure vegetation, and they can create a nuisance. These possible effects of air pollutants are given recognition in the definition of the term "air pollution" contained in some of the laws dealing with air pollution control. For example, the law adopted by New York State last year states as follows: " 'Air pollution' means the presence in the outdoor atmosphere of one or more air contaminants in quantities, of characteristics and of a duration which are injurious to human, plant or animal life or to property or which unreasonably interfere with the comfortable enjoyment of life and property throughout the state or throughout such areas of the state as shall be affected thereby; etc." There is a wealth of information in this definition, and it deserves careful reading. It makes it clear that to constitute a condition of air pollution the contaminant or contaminants must have certain characteristics and must be present in sufficient quantity and for an adequate length of time. This is not to say that air pollution does not exist. It most certainly does or has at times in some areas. But the mere presence of air contaminants in outside air, whether they be gaseous or particulate, does not per se mean that air pollution exists.

On occasion conditions have become such in some few places as to create health hazards which resulted in the deaths of substantial numbers of individuals. Examples are the London fog of 1952, the Poza Rica incident of 1950, and the Donora episode of 1948 in Pennsylvania. That these were very unusual incidents is attested by the very rare frequency of occurrence. The Los Angeles smog, on the other hand, was a real problem on and off for more than five years; and still may be, even though the frequency and severity have decreased markedly during the past year due presumably, in a large measure, to the ban placed on backyard incinerators in October, 1957. Whether this smog constituted a health hazard or not has been argued by many; and because such determination lies within the purview of the physician, it needs no discussion here. But what about the possible chronic health effects caused by normal urban air contaminants? This is indeed a controversial subject. Some hold that such normal urban air contamination in industrial cities does, in fact, produce deleterious effects on the exposed population, effects so subtle as to be incapable of measurement with existing techniques and equipment. Whether such is the case remains to be proved, and a difficult job it will be if the many past fruitless researches on the subject have any meaning.

That air pollutants can injure animals is well recognized. Most, if not all, effects along this line in the past have been of an indirect nature, i.e. the injury to the animals resulted from eating contaminated vegetation or drinking contaminated water rather than as a result of inhaling the contaminants. Instances of injury to animals also have been rather rare considering how close many farms are to industrial plants.

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Real or personal property—such as automobile and

house paint, clothing, window panes, and awnings—have been harmed in many instances by air pollutants of one kind or another. Rubber products, such as automobile tires, are damaged by abnormally high ozone concentrations as have been found in Los Angeles on occasion. Reports of such alleged damage are rather frequent.

Agricultural produce of many kinds, as well as trees and shrubs, can be affected by some few contaminants best known of which is sulphur dioxide. It has been responsible for large losses, on occasion in areas located downwind from and relatively close to industrial plants having huge mass emission rates of this gaseous contaminant.

The fifth and only remaining kind of effect that can be caused by air pollutants is the "catch all" designated nuisance. In the absence of demonstrable damage to health, to animals, to vegetation, or to personal or real property there remain many ways in which air pollution may interfere with the normal activity and well being of people in the affected area. Examples are: (1) dust fall of such magnitude as to require extremely frequent sweeping of the porch and sidewalks and dusting or wiping furniture, windowsills, etc.; (2) odors which are bothersome to some persons or possibly to all exposed persons on certain unusual occasions; and (3) abnormally rapid discoloration of buildings, etc., by smoke. The nuisance aspect of air pollution is covered in the legislative definition of air pollution previously referred to by the words, "or which unreasonably interfere with the comfortable enjoyment of life and property throughout the state or throughout such areas of the state as shall be affected thereby." This intent is not inconsistent with that contained in the definition of the word "nuisance" found in Webster's dictionary, namely, "an offensive, annoying, unpleasant, or obnoxious thing or practice; a cause or source of annoyance, especially a continuing or repeating invasion or disturbance of another's right. But a single act may be a nuisance."

WHAT ARE THE MORE SIGNIFICANT CONTAMINANT SOURCES IN THE STEEL INDUSTRY

Rather than discuss these in order of importance, we will consider them as they arise in the order of material flow through an integrated steel plant, and then make appropriate reference to those which occur by way of ancillary operations.

Coke ovens—Well maintained and carefully operated coke ovens do not release large quantities of air contaminants, but they do release some. Complete control of the emitted gases, smoke and dust is very difficult, but the problem in the case of coke ovens can be kept under adequate control in most areas by top-level maintenance, especially of the doors, and by meticulous operation, particularly while charging.

Unless the stack at the water quenching station is rather close to the plant boundary or to houses or other areas frequented by citizens of the community, the coke quenching should create no problem because the particles of dust carried out through the stack are of large average size and settle to the ground in a rather short distance.

Coke oven gas has a high sulphur content and may create an air pollution problem when burned if it is not desulphurized. It is a rather common practice to remove most of the sulphur from much of the gas produced in steel plant coke ovens. However, frequently the sulphur so removed is merely discharged to the atmosphere by the desulphurizing plant with no reduction in the net mass emission rate. Fortunately, this has not resulted in vegetation damage or other objectionable condition except in some few areas. Where this practice does constitute a problem it can be overcome by recovering the sulphur as such or by using it in the manufacture of sulphuric acid.

Much has been heard in recent years about smokeless charging of coke ovens. The translation of a Russian report[1]* on the subject describes in considerable detail the mechanics of charging, but gives no information on the design or operation of the equipment used to prevent the dust and smoke from flowing out at the oven openings during charging. Those faced with coke oven air pollution problems may be interested in the first of four conclusions at the end of the report. It reads as follows: "The method of smokeless coke oven charging has been in use at the Moscow coke-gas plant for over a year. It should now be adopted by all coke-chemical plants during 1956–57."

Sintering plants—It is rather common now to find sintering plants at the sites of integrated steel plants. They are prolific sources of dust which, unlike an open hearth furnace, for example, is emitted at a number of points. The greatest single source of dust at a conventional traveling-grate type sintering line is the sintering operation which adds particulate matter in the order of 1.0 gr per cu ft to the air drawn across the line for sintering purposes. This rate of air flow for average lines is in the order of 100,000 cfm, but some of the newer lines reportedly will require as much as 280,000 cfm. Other dust sources include the sinter cake discharge at the end of the grate, the cooling table or bed, the hot fines return, and the pug mills. In addition, if the plant construction is rather open, as many are, the wind will pick up much of the fines dropping from conveyor belts, hoppers, etc.

Large diameter cyclone collectors are frequently employed in the sintering air handling system to remove much of the fines from the air before it is discharged. Some few plants have small diameter cyclone collectors as precleaners and electric precipitators as final cleaners on the sintering lines. With such equipment the air is cleaned to about 0.01 gr per cu ft when the precipitators work properly. As a rule the other dust sources are not controlled. Reference to a new sintering plant came to our attention only a few weeks ago. It was stated that 83 per cent of the power used by the plant was consumed by the air handling and cleaning equipment.[2] In this plant air, rather than water, is used for cooling the sinter. The air handling rate per line was stated to be 770,000 cfm (29 tons per min).

Blast furnaces—Even though blast furnace gas, as it leaves the furnace, contains a high dust burden in the order of 10 gr per cu ft; it is almost standard practice to clean such gas before use or discharge to the atmosphere. Conventional cleaning is done in three

* Numbers in parentheses refer to Bibliography at end of paper.

stages, the final stage being electric precipitators. The cleaned gas contains only a trace of its original burden of particulate matter, usually less than 0.01 gr per cu ft.

Another major source of dust from blast furnaces in past years has been that resulting from slips. However, better raw materials preparation, more careful furnace operation and control, supported by improved instrumentation, and higher permissible gas pressure in the gas handling system have reduced slips greatly. It is rather uncommon to experience a slip in a properly operating furnace. This is in stark contrast to the not uncommon frequency of 10 to 20 per day as recently as five to ten years ago.

Open hearths—Open hearth furnaces constitute the greatest single source of solid air contaminants released by steel plants, not because any furnace contributes so much but because of the large number of furnaces. The dust and fume loading in open hearth stack gases has been reported by different persons,[3,4,5] and the results vary widely. Probably the most nearly correct is that reported by Bishop[3] namely, 0.43 gr per cu ft average for an entire heat. Another useful figure to keep in mind is that of 7 to 12 lb of dust and fume per ton of steel produced in open hearth furnaces. They are values reported from plants with electric precipitator type gas cleaning equipment on open hearth furnaces.[6]

Cleaning open hearth gas of its fume and dust burden is inordinately difficult because of the high temperature of the gas (as high as 1600 F if waste heat boilers are not in use), and the extreme fineness of the particles, the mean particle diameter by number probably being less than 0.1 micron. For these reasons the few full scale gas cleaning installations that have been made to date on open hearth furnaces have been electric precipitators. However, such equipment is very expensive, and probably of even greater moment, its installation usually requires extensive ancillary construction because of space limitations at existing open hearth shops.

In an attempt to circumvent some of these objectionable features the American Iron and Steel Institute through its Committee on Air Pollution Abatement has been sponsoring research in this field for more than five years at the Harvard University Air Cleaning Research Laboratory and at other places. Several pilot size units of an experimental collector developed by the Harvard research team have been tested at one of the furnaces of the Bethlehem plant of the Bethlehem Steel Co. In fact, the third model, each one having a larger capacity than its predecessor, currently is under test. This work is producing very interesting results, but it is too early to make any predictions. It is a big step from a small pilot model requiring much manual manipulation and attention to a full scale model of an automatic unit.

In addition to the dust and fumes, open hearth furnaces may discharge considerable sulphur dioxide depending upon the fuel used. Since open hearth stacks are rather high, the discharged gas is hot and rises rapidly and the mass emission rate of SO_2 per stack is not high, there has not been much difficulty from this open hearth contaminant.

Electric furnaces—Such furnaces are comparable to open hearths with two exceptions. In the first place, they present a unique problem in fume capture at the furnace; and in the second place, they do not emit important amounts of SO_2 or other gaseous contaminants. For further information the reader is referred to reference.[7]

Bessemer furnace—The most profuse source of air contaminants in the steel industry is the bessemer furnace. Furthermore, it is emitted in such fashion as to make capture almost impossible. According to one source, the fine fume emitted by a bessemer may be of the order of 20 lb per ton of steel produced.[8] Fortunately a very small and decreasing percentage of the steel produced in America is produced in bessemer furnaces. Consequently, it is unlikely that the fabulous sums of money required for control will be forthcoming with the possible exception of a few rare instances where such furnaces create a real problem of air pollution.

Scarfing—Both hot and cold scarfing produce large amounts of fume. However, manual scarfing generates the fume at a much slower rate than mechanical scarfing; and only major mechanical scarfers, such as hot scarfing units in billet mills, produce sufficient fume to be of possible concern. No report as to fume concentrations in the exhaust air from scarfing operations has come to our attention. Even though each such unit produces much fume, the total mass emission rate from scarfers is not great because of the rather small number of units in use in the industry.

Power houses—Steam and power generating plants, especially if coal-fired, are potential sources of air pollution, both particulate (fly ash) and gaseous (SO_2). However, these, as a rule, are not major problems in the steel industry. They have been covered abundantly in the literature on this subject so that no further discussion is warranted at this time.

Miscellaneous—There are many miscellaneous sources of air contaminants in the steel industry, most of which are of no consequence in the main. In unusual cases one or more of them may create a problem. These include acid pickling operations, spray painting operations, reheat furnaces including soaking pits, foundry cupolas, foundry dust control discharge stacks, raw materials handling and storing operations, and coke by-products plants.

A SUGGESTED SOUND PHILOSOPHY TO GUIDE REGULATIONS

In the past too much attention has been paid to air contaminant control and too little to the solution of problems created by air pollution. This unbalance is continuing although more and more there is evident a tendency to concentrate on solving problems created by air pollution rather than to blindly insist on air contaminant control across the board. The two are quite different as exemplified by the situation in Pittsburgh and St. Louis in contrast to that in Los Angeles. In the former cities, the real problem was one of smoke (unburned carbon) which discolored buildings and exposed materials rapidly. Also, it shut out much of the sunlight. The problem was solved by decreasing greatly the amount of smoke produced. This was accomplished by setting up and enforcing regulations as to the kind of fuel that may be burned in the furnaces of the homes, buildings and industries of the city, and by a program of education as to proper firing techniques

to achieve minimum smoke production. The regulations did not call for immediate rigid control of air contaminants of all kinds, but rather they were aimed very wisely at solving the problem caused by air pollution. Anyone who has experienced the transformation that has been brought about in these and certain other comparable communities can attest to the great improvement achieved.

In Los Angeles, on the other hand, because of the nature of the problem and the hue and cry of the affected citizens, time was not available to permit delineating the problem to ascertain exactly what caused the haze and the eye smarting. Regulations were adopted restricting severely the discharge by industry of all air pollutants. While the general air contamination of the area was decreased thereby, the problem was not solved. The reason, obviously, was that the cause of the problem had not been determined. Because the eye irritation persisted, agitation for more controls grew louder and stronger; and the research staff of the Los Angeles County Air Pollution Control District searched feverishly for a clue to the cause of the problem. Several years ago their findings indicated that it was the unburned hydrocarbons, subsequently irradiated by the sun (more recently termed "sunburned hydrocarbons") that were the principal cause of the trouble. This meant that automobiles and trucks, the popular backyard domestic incinerators, gasoline filling stations, gasoline storage stations, painting and lacquering operations, and a host of other operations which released hydrocarbons to the atmosphere were at fault. Industry and commercial establishments again were made the "whipping boy"; but even after these were brought into line, the smog continued. Since a satisfactory solution to the automobile situation was not known, it was decided that backyard incinerators must be eliminated, and October 1, 1957 was set as the effective date of the ban. While reports are contradictory as to the reduction in smog forming agents achieved by the incinerator ban, the fact remains that there has been an improvement in the smog situation in Los Angeles. There is little doubt that if and when an effective and practical method is devised for eliminating the unburned hydrocarbons currently discharged by automobiles, the smog problem in Los Angeles will be eliminated completely. What is more, it is not improbable that if the automotive and incinerator sources of hydrocarbons and those industrial ones contributing similar pollutants to the air had been regulated in the first place, the problem would have been solved without the need for the harsh restrictions as to particulate matter emissions and SO_2 imposed upon industry in the area.

Admittedly the situation in Los Angeles was and still is unique. The problem there was ever so much more difficult of definition than in Pittsburgh or St. Louis. Nevertheless, the example cited does serve to show that merely regulating all air pollutants discharged by industry is not a guarantee that an air pollution problem will be solved, and that air pollution problems often can be solved by relatively limited and lenient restrictions providing the problem is adequately defined. Of interest in this connection are the findings from recent appraisals of the air pollution situation in the state of New York. As a result of several different independent studies it has been concluded that industry is responsible for less than half of the contaminant burden in the air over the state.

Another important factor in a logical approach to air pollution is that each area is different from every other one and in no area is 95 per cent reduction in air contaminants needed overnight. Since air contaminant control is costly and if regulated blindly places a needless economic burden on the cost of many commodities, there seems to be little compelling reason for regulating air contaminants unless a problem exists. There is no merit in regulating for the sake of regulation. Wherever a problem of air pollution exists in any area, appropriate and effective air pollution regulations should be adopted and enforced on an area basis. However, the regulations should be aimed at the objective of solving the problem. General air contaminant control, or highly restrictive control may be, and often is, unnecessary. Intelligent and scientific study of a given problem usually will disclose the cause and earmark the sources. Sensible regulations then can bring about a complete solution to the problem at a minimum cost to all concerned.

Even where well delineated problems do exist, there is little need for all contributing sources to be decreased by almost 100 per cent at once. The problem did not arise in a day; it has been long, probably many years, in developing. This is a natural outgrowth of the increasing population, industrialization, mechanization and urbanization. The air contaminants ultimately may reach such concentration as to create a problem of one sort or another. More than likely a 10 to 25 per cent reduction in the contributing contaminants would eliminate the problem. Why then should the control program not be undertaken on a long term basis (5, 10 or 25 years, depending on the circumstances) in order to have as small an impact as possible on the economy of the community and of the offenders.

What this all means is that the rather common regulatory approach to air pollution control appears not to be the best one. By common regulatory approach is meant the procedure in which (1) by virtue of existing or newly enacted statutes all political subdivisions, such as cities, towns, villages, boroughs, townships, and counties, or combinations thereof, are given the power to adopt and enforce air pollution control laws or regulations; and (2) the political subdivisions, or a combination of them, without adequate consideration as to the problem to be solved adopts a borrowed law or ordinance which may be (a) wide of the mark, (b) needlessly restrictive, or (c) needlessly costly to live with. The crux of the shortcoming in this approach lies in the failure of the regulatory body to analyze the problem and to write intelligent regulations which are aimed specifically at solving the problem. This is not a criticism of the regulatory bodies because, with few exceptions, such agencies do not have the technical personnel to analyze the many complexities of the problem and to write practicable and effective regulations, nor do they have the funds to employ such personnel should they be available. As a result some "model" smoke ordinance or the ordinance developed by some other regulatory body for some widely different area and conditions is adopted essentially verbatim. Not only may such regulations

be needlessly harsh; but what is more to the point, they may not even bring about a solution to the problem.

A practicable solution to this difficulty is to vest in an appropriate agency at the state level the responsibility of supplying the technical personnel of all professional disciplines for the study and research required to define the problem and prepare regulations aimed at controlling it. Admittedly this is distasteful to many because it is encroaching upon home rule, but how else can the technical personnel required to analyze and solve the many complex facets of air pollution and its control be made available at a reasonable cost to the people of the community and of the state. Even if an adequate supply of qualified personnel in the field of air pollution were available, the cost of staffing every political subdivision or combination thereof with them would place a prohibitive tax burden on the people of each state, a burden which for state and local governments alone in this country increased from 10 to $20,000,000,000 in the eight-year interval from 1950 to 1957 inclusive.[9] It is important to remember in this connection that we are considering air pollution in its entirety, not only smoke. For many years prior to maturity of the chemical industry, smoke control ordinances were in existence and were being administered by relatively untrained personnel available at the price most communities could afford to pay. The problem was rather simple, the entire kit of investigative tools consisting of a Ringleman chart and, in some few instances, dust fall jars and a sensitive balance. Just as these tools are wholly inadequate for evaluating air pollution problems today, so also are personnel without proper education and training. In fact teams comprising professional personnel from the disciplines of engineering, chemistry, toxicology and medicine are needed to make worthwhile appraisals of any potential pollution problem. It is high time that we discontinue the practice of evaluating jet age problems in air pollution with horse and buggy era methods, equipment and techniques.

There are many people, of course, who feel that across-the-board air contaminant control is necessary and practicable. They argue that industry simply does not want to spend the money to bring its house in order. It is unfortunate that many of these people do not have access to the facts in the matter. Contrary to the implications in the many dramatic accounts in newspapers and some popular journals, there is no authoritative proof to show that air contamination in the degree normally encountered in most cities and communities is deleterious to the health of the citizens of the communities. In fact, there is considerable evidence to show that such normal pollution has no demonstrable effect on the health. In the same way, the newspaper accounts and those in popular journals as to air pollution control installations imply that all air contaminant control amounts to is the purchase and installation of some packaged filter. The facts that many filtering units that are installed do not achieve their objectives, a filter which works at one place may not work at another because of different conditions, and practicable solutions to many problems are not known by even the best qualified persons, never see the light of day in public print except on a very isolated basis. In short there are many valid reasons for not rushing helter-skelter into air contaminant control. There is need for increased research and study into the vagaries and the effects of air pollution and into new and improved methods of removing air contaminants from the gases discharged to the atmosphere by automobiles, domestic dwellings and public buildings as well as by industrial plants. There can be little doubt that such research will result in great savings in the ultimate cost of air pollution control. Because such cost must find its way into the price of the commodities purchased by the public; emphasis on research at this time, rather than on blind across-the-board air contaminant control, will save money for every man, woman and child.

WHAT IS HAPPENING IN THE FIELD OF AIR POLLUTION CONTROL LEGISLATION

The political subdivisions of a state, the counties, cities, towns, townships, boroughs, etc., do not in general have the authority to adopt air pollution regulations unless empowered by state law to do so. Most, if not all, states by enabling statutes have granted authority to certain of their political subdivisions to adopt ordinances of general or specific kinds, including air pollution control; and in a great number of instances the municipalities have taken advantage of such legislation to set up their local control ordinances.

According to Rogers[10] it is only relatively recently, however, that legislation in the field of air pollution control granted state wide control authority to a state-level agency. Prior to 1954 only one state had enacted a law specifically authorizing a comprehensive state wide air pollution control program at the state level, but since then legislative activity in this direction has been growing rather rapidly. For example, of the 17 states known to have considered legislation of one sort or another in 1957, ten considered state level authority, five considered enabling acts granting authority to one or more kinds of political subdivisions, and the others considered legislation on other aspects of the problem. Of the ten considering state level authority, five (Colorado, Delaware, Florida, Minnesota and New York) enacted such laws. Enabling acts, on the other hand, were enacted by only two states, namely Nevada and Washington. In Pennsylvania both kinds of bills were introduced but none was adopted. The whole subject has been referred to the Joint State Government Commission for study and recommendation to the 1959 Legislature.

In our opinion the fact that more and more laws empowering state level agencies are being adopted has more than passing significance. It suggests that the relevant facts in the matter are coming to the attention of the legislators, that they are coming to realize what a complex and difficult problem air pollution evaluation and control is, and that it can be done economically and equitably, but at the same time effectively, only by teams of qualified and understanding engineers and scientists who are completely divorced from political influence or dependence.

To gain the cooperation and support of industry, as well as of the other persons or legal entities contributing contaminants to the outside air, it is imperative that the attitude exhibited by the regulatory agency be a realistic and understanding one. Such attitude is

expressed rather clearly in the "declaration of policy" contained in the recently adopted New York State Law. To wit "It is declared to be the policy of the state of New York to maintain a reasonable degree of purity of the air resources of the state, which shall be consistent with the public health and welfare and the public enjoyment thereof, the industrial development of the state, the propagation and protection of flora and fauna, and the protection of physical property and other resources, and to that end to require the use of all available practical and reasonable methods to prevent and control air pollution in the state of New York. It is further declared that this can be done most effectively by focusing on goals to be achieved by a maximum of cooperation among all parties concerned and that codes, rules and regulations established under the provisions of this article should be clearly premised upon scientific knowledge of causes as well as of effects."

Further evidence of a realistic approach to the problem may be found in the regulations under the Oregon law, a state level law. These regulations contain the first evidence that has come to my attention that the "point of use of the air" is recognized as being the governing factor in deciding whether air pollution exists, and if so, how much and what kind of control is needed.[11] The "point of use of the air" concept has received very little attention, yet it is so basic to the whole subject matter as to make it difficult to see why it is not in common use. All this concept means is that it is the degree of contamination at the point or in the area where the alleged condition of air pollution exists that shall govern. To illustrate, I shall lift two sections from the Oregon regulations. They are:

"2.2 Particle Fallout Rate: The particle fallout rate in a residential or commercial land use area shall not exceed the normal background value by more than 15 tons per square mile per month; excepting that in heavy industry land use areas the particle fallout rate may be 45 tons per square mile per month above the normal background value as measured by the procedures adopted by the Authority or equivalent and acceptable methods of measurement.

"2.3 Suspended Particulate Matter: The suspended particulate concentration shall not exceed 150 micrograms per cubic meter more than the normal background value at representative sampling stations in residential and commercial land use areas; except that in heavy industry land use areas the suspended particulate concentration may be 250 micrograms per cubic meter above the normal background value as measured by the procedures adopted by the Authority or equivalent and acceptable methods of measurement."

These regulations give even further evidence of the complete understanding apparently possessed by the persons responsible for drafting them. Thus, in communities wherein there may be several sources contributing to a problem of air pollution, a determination shall be made of the approximate percentage contributed by each source in order that equitable control can be achieved. This, in our opinion, is the only sensible, scientific and economically sound way to approach the problem or air pollution control. Admittedly, an indispensable prerequisite for the drafting and administration of regulations of this kind are qualified and understanding personnel in the regulatory agency. This is all the more reason why the responsibility for air pollution control regulation belongs in a political unit large enough to be able to afford employing a team of competent persons.

The term "state level law" or "state level authority" is not synonymous with "state wide regulation." Air pollution, if it exists at all, exists on an area basis. Each air pollution area is unique. To solve an air pollution problem in any area at the least cost to all persons affected, the regulations must be tailormade to fit the condition and situation. It simply does not make sense to try to solve the widely different air pollution problems that may exist in different areas within a single state by adopting and enforcing state wide regulations. State-level authority and responsibility, yes, but state wide regulations, decidedly no.

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ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

Mechanical Inching Drives

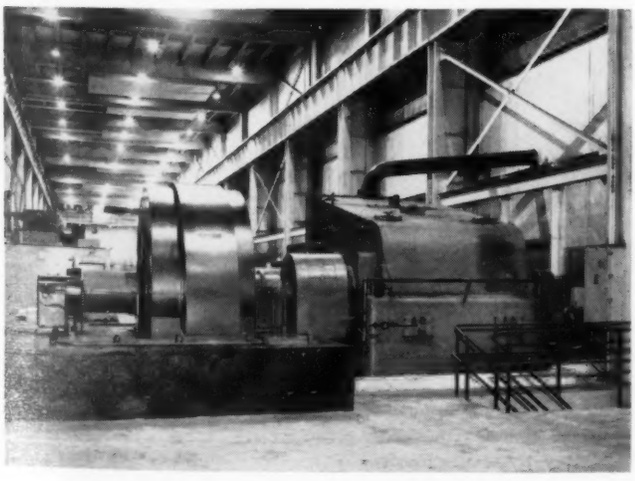
. . . . non-reversing auxiliary a-c induction gearmotors are used with reversing gearing and engaging solenoids to forward and reverse jog the roughing mill stand drive spindles through the mill speed reduction gear . . . . electrical interlocking is provided to insure against simultaneous energizing of the main drive and inching motors . . . its mechanical design insures automatic disengaging of the inching drive when the main drive motor is started.

"APPLICATION AND OPERATION ASPECTS"

by H. Kermit Fish,
Assistant Electrical Superintendent,
Weirton Steel Co.,
Div. of National Steel Corp.,
Weirton, W. Va.

IN planning our 54-in. hot strip mill, it was decided to install five roughing mills and to use two 4000-hp synchronous motors that had previously been purchased on the No. 1 and 2 stand drives and to purchase three 6000-hp synchronous motors for the No. 3, 4 and 5 stand drives. The operating people requested some method of inching the drives so that the drive spindle and roll could be alined.

Figure 1 — Because the substation is too narrow to accommodate the inching drive on the end of the motor shaft, the inching drive was mounted on the other end of the mill speed reduction gear.



Several methods of inching the drives, suggested by electrical manufacturers and Weirton personnel, resulted in the selection of a mechanical inching drive. We inspected one of these drives that was installed on a turbine at the electrical manufacturer's plant and decided to install this type of equipment on our drives.

The inching drives are mounted on the gear drive opposite the drive motor. The reason for installing the inching drive in this location is because the substation is too narrow to accommodate the inching drive on the end of the motor shaft as shown in Figures 1 and 2. The pinion drive shaft was extended to accommodate a gear which is driven by the inching drive when the gears are engaged. For economical reasons, we decided to use a-c motors for these machines. All five machines are duplicates. They are driven by 20-hp, 550-v, 3-phase, 60-cycle, 1080-rpm, high-slip motors. The mill spindle speeds with these drives are shown in Table I.

Due to these slow speeds it was decided to install

Figure 2 — This is a closeup of the inching drive gearmotor and gearing unit at the end of the mill speed reduction gear.

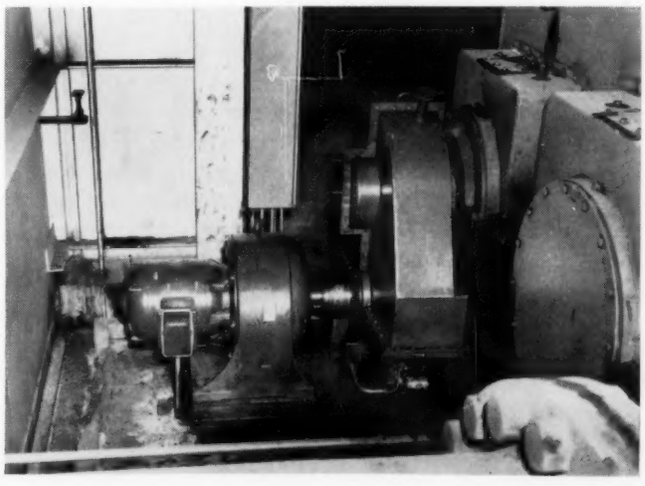


TABLE I	
Stand	RPM
No. 1	0.257
No. 2	0.345
No. 3	0.52
No. 4	0.73
No. 5	0.85

reversing controls on the motor to speed up the alining of the roll and spindle so as to save delay time on the mill. The inching drive control and the main drive motor control are interlocked, so that one cannot be energized with the other operating.

After the rolls in the mills are changed, the operator screws the rolls down until they are together and runs a trial sheet through the mill to check for roll level and alinement. This is done by the inching drive turning the rolls. There is enough torque in the inching drive to do this work.

No. 1, 2, 3, and 4 stand drives were installed and placed in operation August 17, 1955, and No. 5 stand on January 10, 1956.

The operating people are well satisfied with the operation of these machines, and as of this date there has been no maintenance on any of them.

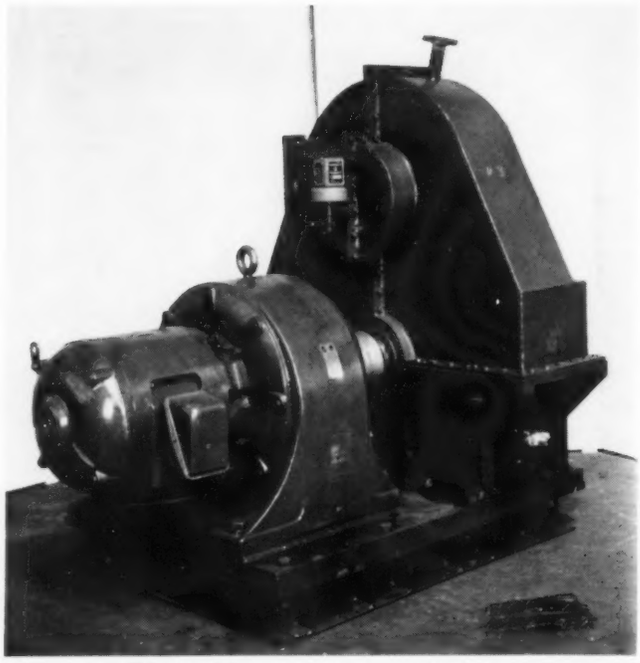


Figure 1 — The inching unit is comprised of a separately mounted gearmotor which drives two oppositely-rotating idler gears, both of which are engaged by its solenoid, one at a time depending on the jogging direction, with a gear keyed to the high-speed shaft of the mill speed reduction gear.

"ENGINEERING ASPECTS"

by Dr. J. R. Shields,

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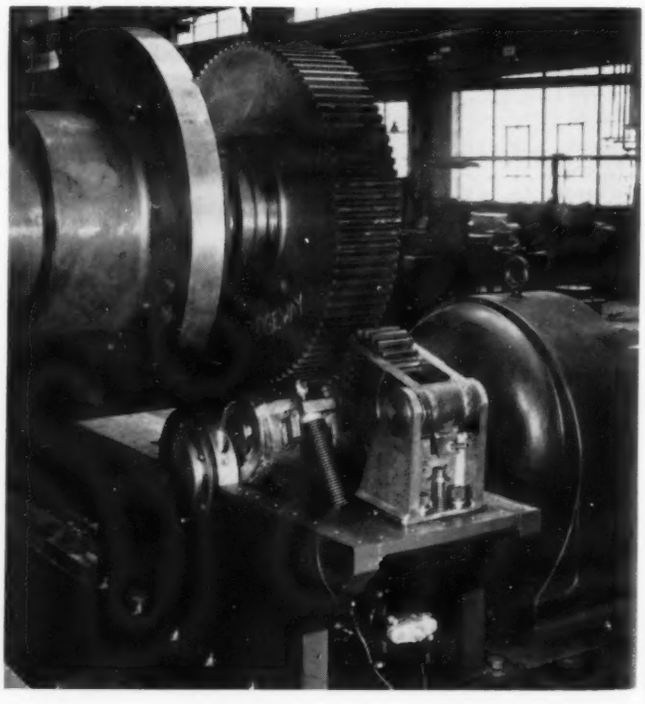
CONVENTIONALLY, various electrical methods are employed with synchronous rolling mill drives to obtain slow inching speeds for roll changing operations. It was decided that an adaptation of the familiar turbine generator mechanical turning gear would prove advantageous for the inching of rolling mills. During the design of the new roughing mill, the potentialities of applying mechanical inching to this mill were investigated. This resulted in the selection of mechanical units for the five stands. The primary difference, other than torque rating, from turbogenerator turning gears was the provision for reverse operation.

The inching unit assembly, illustrated in Figure 1, is comprised of a separately mounted gearmotor and engaging idlers that drive into an output gear that is directly overhung on the high-speed pinion shaft of the mill reduction gear. In operation either the reverse or ahead idlers are engaged with the output gear by solenoids that rotate the idlers about the input pinion. The idler gears are always in mesh with the input pinion driven by the gearmotor. Figure 2, an illustration with the gear cover removed, shows the output gear, idlers and cages, and throw-out cam for reverse inching. The gearmotor and one of the engaging solenoids are also illustrated.

During rolling operations the inching drives are not operating. They are mechanically disengaged from the output gear. When inching is desired, either the ahead or reverse idler is engaged; and the gearmotor is started

Figure 2 — With the cover of the gear unit removed, the two inching idler gears (small gears directly under the large gear), the bull gear (the large gear), the idler throw-out cam assembly with its smaller pinion (the gear in the foreground), one of the idler-engaging solenoids, and the gearmotor can be seen.



simultaneously by appropriate electric circuitry.

While interlocks in the control circuit were provided to prevent operation of the inching drive with the main motor running, the idler pinions were designed and arranged so that the torque forces are in a direction to throw the idlers out of engagement and prevent overspeed damage to the inching units. This was easy to achieve for the idler that inched in the normal direction of the main motor. Merely having the idler on the correct side of the output gear results in gear meshing forces that maintain the idler in engagement during inching but throw it out of engagement if the main motor tries to drive the inching unit. Because the main motor always rotates in the same direction, the reverse idler cannot be located to provide a disengaging force by torque reactions. Whether the main motor or the inching unit is driving, the torque forces always act to hold the idler in engagement. The only solution was to provide a mechanical means actuated by the bull gear to push the reverse idler out of mesh if the main motor was started. This took the form of an auxiliary pinion mounted on a rocking pivot and in contact with the reverse idler cage. This pinion, by means of an overrunning clutch, could rotate with the output gear in the reverse inching direction but locked in the other direction. Thus, if the main motor attempted to drive the reverse idler cage, the auxiliary gear clutch locks and turns about the pivot center pushing the idler out of mesh. In the disengaged position both the idler and auxiliary pinion are out of mesh with the gear. The rocking pivot is necessary to permit engagement of the auxiliary gear and reverse idler by the reverse inching solenoid. The throw-out cam assembly, including overrunning clutch, is based on a 3000 lb-ft torque rating which is twice that calculated as necessary to disengage the reverse idler considering the design inertia of the inching drive and the acceleration curve of the main motor.

Unknown torque requirements for inching dictated a design rating of approximately 40,000 lb-ft, equivalent to the starting torque of the main drive motors. The gearmotor is driven by an 1150-rpm high-torque motor so that an inching speed of about 6 rpm is had on the high-speed pinion. The roll speed varies from approximately 0.25 rpm because it depends on the main reduction gear ratio. Field experience has proved this torque rating to be ample for the job.

Mechanical design of these units is very conservative, making operating stresses very low, and a long operating life is expected. Tests at the plant demonstrated that mechanical inching units of this design would perform as intended, including automatic disengagement of the idlers on starting the main motor.

Discussion

PRESENTED BY

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D. J. Fapiano: The design of this equipment makes it self-disengaging for two directions of inching provided the driving motor can be started in only one direction of rotation. Can this equipment be modified to make it self-disengaging when used with a motor that can be started in either direction without significantly increasing the complexity of the gearing?

There has been no mention made of the economic comparison of mechanical and electrical spotting methods. Would Dr. Shields care to comment on such a comparison for this particular application?

Our experience has been that, unless mechanical spotting is preferable for other reasons, electrical spotting is less expensive for large drives requiring high per-unit spotting torque. The reason becomes apparent when we consider that the cost of mechanical spotting equipment increases almost directly with torque, while the cost of a large portion of the equipment involved in electrical spotting is not influenced by the torque requirements.

We will, of course, continue to recommend whichever of these two alternate methods is indicated by the economic and operating considerations of the particular application.

Dr. J. R. Shields: If the main motor can drive in either direction, the only answer I can think of offhand is to have another throw-out cam on the other pinion stands.

As to whether mechanical inching is more economical I cannot give a good answer. I think it is primarily because even though these drives have been built and installed, we do not know whether we have too much torque. This affects the economics and choice of system. We know they do the job, but there is no way of setting the initial torque rate. Perhaps these machines could be instrumented; it would be interesting to find out just what is the lowest torque rating that could be used. We have absolutely no idea and settled on the starting torque of the main motor.

As to the relative cost for various torque designs, I cannot give an answer because I do not know. ▲

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DEVELOPMENTS In The IRON AND STEEL INDUSTRY During 1958

by I. E. MADSEN

Technical developments are centered on automatic control. ▶

GENERAL

NO word can perhaps better express the year 1958 other than it was a year of reappraisal. It was ushered in with reduced steel production which began in 1957. Further slackening was expected. Further slackening came—to far lower depths than had been expected by anyone in or out of the steel industry. The operating rate which started with 56.5 per cent in January dropped to a low of 47.8 per cent in April and then gradually recovered with the exception of a setback in July. Not until the last quarter did it go over 70 per cent.

The important effect was to make steel management look very closely at their operating plans and their costs. With many plants operating at half capacity, it seemed ludicrous to emphasize expansion. As a result, many programs were suspended, postponed or, in some cases, completely cancelled. Programs which had gone too far to be cut back economically were carried to completion. Most of these cutbacks are not permanent, but merely postponed. Plans whose objectives were primarily improvement of efficiency were continued.

As a result there was a great deal of belt tightening, a sharp look at many expensive practices and a trimming of the fat which had accumulated over the past lush years. The steel industry found that it could make money at operating rates well under previous breakeven estimates. This was a tribute to the efforts of management in bringing their facilities up to date, improving methods and selecting new equipment and processes.

Part of the reduction in the operating rate was due to sharp cuts which many steel users made in inventories. Most of the year saw steel buyers using more material than they bought, a trend which continued into the last quarter. Its reversal toward the end of the year led to predictions that 1959 would see production reaching 100,000,000 to 110,000,000 net tons of ingots.

Total production of steel in 1958 was about 84,900,000 tons or 60.3 per cent of the 1958 capacity. Of this, open hearth production totalled about 75,700,000 net tons (61.8 per cent of capacity) bessemer production totalled 1,400,000 tons (34.8 per cent of capacity); and electric furnace production (in AISI statistics this includes oxygen process and crucible steels) totalled 7,800,000 tons (54.2 per cent of capacity).

These figures compare with a total of 112,714,996 ingot tons in 1957 consisting of 101,657,776 tons from open hearths, 2,475,138 tons from bessemers, and 8,582,082 tons from electric.

Blast furnace production in 1958 was about 57,600,000 net tons from 265 furnaces or 63.4 per cent of the 1958 capacity of 91,000,110 tons, compared with 79,338,932 tons (including ferromanganese) produced in 1957. Coke production was about 54,000,000 tons in 1958.

Shipments of finished steel in 1958 totalled about 61,500,000 net tons compared with 79,894,577 tons in 1957.

In 1958, the steel industry added about 7,000,000 tons of steelmaking capacity, and 3,600,000 tons of blast furnace capacity.

In 1958, some operating trends previously begun continued, some at a greatly accelerated pace. The decreasing quality of ore and the high investment cost in new iron-making facilities are leading toward more and more sintering. In steelmaking, there is a continued trend to more use of oxygen. Since this program has been limited somewhat by the availability of oxygen, oxygen plant construction has had a field day, and this will probably continue for some time.

The top-blown oxygen converter is now an accepted practice. Many steel companies are studying the possibilities of such units, primarily because of their low capital cost and competitive operating costs.

Also, work with oxygen lances through the roof of open hearth furnaces has indicated a surprising potential for increased production. Most of this work indicates that refractory life will be a problem but the trend to basic refractories may overcome this objection.

In the rolling mill field there is a continued trend to automation and to the systems concept for the installation of rolling mill drives. Digital control and automatic recording of data are being used to adjust production processes so the product will meet the required specifications.

An interesting study made during the year indicates

that half of the capacity of the iron and steel industry was installed prior to 1946, 16 per cent was installed between 1946 and 1951, and an additional 37 per cent has been installed since that time. It is estimated that it will take almost $3,000,000,000 to replace existing obsolete facilities.

Another major expenditure faced by the industry is some $20,000,000,000 to build the 3,000,000 tons of new capacity felt to be needed each year for the next 20 years. Raising this money is another industry problem.

The estimated total of capital expenditures for the iron and steel industry in 1958 was $1,199,000,000 compared with $1,844,000,000 in 1957. Estimated expenditures for 1959 are $1,043,000,000 or a drop of about 13 per cent.

Engineering plans for the proposed new Barium Steel plant to be located on the Delaware River in Burlington, New Jersey, have been practically completed. Based on construction and equipment bids, it is estimated that the initial 800,000-ton plant will require an investment of $50,000,000. The project will include a 1700-ton per day blast furnace, a 200-ton per day oxygen plant, and a 2100-ton per day oxygen converter plant. Ingots will be shipped to other plants for rolling. Plans call for an eventual capacity of 2,000,000 tons per year for this plant, with a product mix of plate, structural shapes, bars and seamless tube.

A matter of concern to the American steel industry is the rate of increase in foreign steel producing capacity. With the increased emphasis on nationalism, there is a natural feeling in most countries that they should produce their own steel. As a result, many markets available to the United States will gradually be shut off. What is worse, 1958 steel imports in the United States ran at the highest rate for several years. Total imports are estimated at about 1,500,000 tons, 10 to 15 per cent above 1957, and this, at a time when domestic mills were slack.

Belgium and Luxembourg shipped more than 40 per cent of the steel imported into the United States, with France, West Germany, the Netherlands and Italy supplying another 30 per cent. A major item purchased from overseas was wire products.

One of West Germany's major steel companies, the August Thyssen Huette A.G., negotiated a contract for more than $150,000,000 of steel products to be shipped to Argentina.

All of this foreign competition, both at home and

Jones & Laughlin Steel Corp. started a new plant for finishing stainless at Louisville, Ohio.

abroad, is abetted by the ever-widening gap between production costs here and overseas. An important factor in the cost picture is increased payroll cost, a result of automatic increases incorporated in the prevailing steel contract. The average hourly earning rate in the last half of 1957 was $3.00 an hour, including vacation and holiday pay, but not including fringes. As of the year-end, the average hourly rate was up to $3.27 plus 33¢ for fringes such as pensions, insurance, SUB, social security, etc.

Despite the increase in wage costs at mid-year there was a great deal of hesitation in raising steel prices, principally due to the business slump. However, early in August Armco Steel Corp. increased prices on some sheet and strip products by some $3.00 to $7.00 a ton. This was followed by other companies. Increases were added later to the majority of other steel products.

Jones & Laughlin Steel Corp. entered the stainless flat products market when it put its new Louisville plant into operation late in the year. This development followed purchase in 1957 of the Rotary Electric Steel Co. in Detroit, which produces the ingots. Ingots are processed into hot rolled bands on the strip mill at Pittsburgh Works.

Pittsburgh Coke & Chemical Co. initiated production of ferromanganese this year.

Arizona entered the steel business as Yuba Consolidated Industries relocated a plant on a site near Tempe, Ariz. This company bought a 36,000-ton per year plant of Western Rolling Mills, Inc. and moved it from San Jose, Calif. Target for first production was the end of 1958 with a line of reinforcing bar, merchant bar and light structural shapes.

The Seidelhuber Iron and Bronze Works of Seattle started construction on a merchant bar plant in Fairbanks, Alaska. Steel will be supplied by an electric furnace. Initial capacity is expected to be 1000 tons monthly.

A new steel plant may be built by the Crescent City Mineral Co. near Eureka, Calif. A direct reduction process is being considered for the plant.

National Steel Corp. purchased Crown Cork & Seal Co.'s tin plate manufacturing equipment at a reported cost of $5,300,000. The equipment includes cold reducing mills and supplementary equipment for making electrolytic tin plate. Located in Baltimore, the facilities had an annual capacity of about 100,000 tons.

As a result of the decline in the railroad industry and the demand for railroad products, U. S. Steel Corp. discontinued the manufature of railroad track items at Johnstown Works. The corporation also stopped rail production at the Edgar Thomson works, which has been a rail producer since its inception. Rail products are being concentrated at the corporation's Gary plant.

A big news item during the year was the Federal District Court's ban on the proposed merger of Bethlehem Steel Corp., and Youngstown Sheet & Tube Co. Federal District Judge Edward Weinfeld turned down the merger request on the grounds that it would remove a major competitor from the steel industry and lead to a substantial increase in concentration of steelmaking facilities in the hands of the largest producers.

The merger of the Armco Steel Corp. and the National Supply Corp. became effective April 30. National Supply retained its name and continued operations as a subsidiary of Armco. The merger balanced out Armco's products, put Armco into the pipe business and provided National Supply with a source of steel.

At the time of the merger, Armco announced plans to eventually build a 100,000-ton steel plant and seamless pipe mill. Probable location would be adjoining Armco's Sheffield Division plant at Houston. Armco management indicated that a direct reduction plant was a possibility in this program.

DETAILED EXPANSION

Despite the fact that 1958 was to a certain degree a year of recession, it was still a substantial year for modernizing equipment and installing new facilities in the steel industry. By the end of the year, because of a wide variety of capital improvement programs, the companies were better equipped than ever before.

Some of the principal improvements in the works during the year, either completed, started, or in progress, were some twenty rolling mills of various types and sizes. These included blooming mills, slabbing mills, hot strip mills, structural mills and cold rolled

PARTIAL LISTING OF ANNOUNCED EXPANSION PLANS—1958

(c) Denotes Completion in 1958

Company and plant	Cost	Additional ingot capacity, tons	Steelmaking facilities	Additional iron capacity, tons	Ore preparation	Hot mills	Cold mills	Finishing facilities	Heating furnaces and pits	Miscellaneous
Acme Steel Co. Calumet Harbor, Ill.	$ 23,000,000	450,000	Two 50-ton oxygen converters	Two 25-ton hot blast cupolas	.....	Blooming and billet mill	.....	.....	Three batteries 4-hole soaking pits	Oxygen plant
Alan Wood Steel Co. Conshohocken, Pa.	$ 5,200,000	.....	One open hearth mold yard crane. One 400-ton stripper crane	.....	.....	.....	.....	.....	.....	Install iron powder plant. Instrumentation on coke gas system to eliminate gas holder
Armco Steel Corp. Ashland, Ky.	$ 1,500,000	.....	.....	.....	.....	.....	.....	.....	.....	River termina
Butler, Pa.	.....	.....	120-Ton oxygen plant	.....	.....	.....	.....	.....	.....	.....
	$ 80,000,000	.....	.....	.....	.....	56-In. hot strip mill (c)	.....	.....	Three 80-ft slab heating furnaces	.....
Sheffield Steel Div. Kansas City, Mo.	$ 10,000,000	.....	.....	.....	.....	10-In. rod mill	.....	.....	.....	.....
Babcock & Wilcox Co. Koppel, Pa.	$ 13,000,000	.....	Electric furnace	.....	.....	.....	.....	.....	.....	.....
Barium Steel Corp. Phoenixville, Pa.	$ 500,000	.....	.....	.....	.....	.....	.....	.....	.....	Oxygen plant (c)
Bethlehem Pacific Coast Steel Corp. Seattle, Wash.	$ 25,000,000	174,000 tons	Two 100-ton electric arc furnaces	.....	.....	32-In.-2-high reversing blooming mill (c). Merchant bar mill (c)	.....	.....	Two batteries soaking pits (c)	.....
Bethlehem Steel Corp. Bethlehem, Pa.	.....	.....	.....	Blast furnace	.....	.....	.....	.....	.....	.....
Johnstown, Pa.	.....	.....	.....	Enlarge blast furnace	.....	.....	.....	.....	.....	.....
Lackawanna, N. Y.	.....	.....	.....	.....	.....	.....	.....	.....	.....	Office building
Sparrows Pt., Md.	.....	.....	3 Open hearth furnaces (c)	Blast furnace	.....	.....	.....	Electrolytic tin plating line	Built block of soaking pits	Rebuilt two batteries of coke ovens
Steelton, Pa.	.....	.....	.....	.....	.....	20-In. bar mill improved	.....	.....	.....	.....
Ceco Steel Products Co. Lemont, Ill.	$ 11,000,000	120,000	Electric melt shop, with two 12-ft, 18-ton electric arc furnaces	.....	.....	Bar mill. Billet mill	.....	.....	.....	Service building
Calstrip Steel Corp. Los Angeles, Calif.	$ 250,000	.....	.....	.....	.....	.....	.....	.....	Continuous anneal and pickling line	.....
Copperweld Steel Co. Wire & Cable Div. Glassport, Pa.	$ 1,325,000	.....	.....	.....	.....	.....	.....	Aluminum-covered steel wire and rod production facilities	.....	.....
Superior Steel Div. Carnegie, Pa.	$ 1,750,000	.....	.....	.....	.....	.....	Sendzimir mill	.....	.....	.....
Crucible Steel Co. of America Midland, Pa.	$ 10,000,000	.....	.....	.....	.....	Tables 2-High hot strip mill (c)	Sendzimir mill (c)	Two continuous anneal-ing and pickling lines (c)	Two 3-hole soaking pits (c)	Build up slitting lines, stretcher leveller, shears, silicon coating line (c)
Syracuse, N. Y.	$ 1,500,000	.....	Vacuum melting (c)	.....	.....	.....	.....	Bar turning (c)	.....	Research laboratory (c)
Trent Tube	$ 160,000	.....	.....	.....	.....	.....	.....	.....	.....	New tube making facilities (c)
Fuel Division	$ 240,000	.....	.....	.....	.....	.....	.....	.....	.....	Two coal dryers, slate loading machines, chain conveyor, cutting machines, mine cars, coal barges (c)
Park Works	$ 100,000	.....	.....	.....	.....	.....	.....	.....	.....	Shot blast unit (c)
Spring Division	$ 54,000	.....	.....	.....	.....	.....	.....	.....	.....	Double spindle grinder (c)
Titanium Division	$ 470,000	.....	.....	.....	.....	.....	.....	Billet finishing and billet and slab conditioning facilities (c)	Research heating furnace and modify existing furnace (c)	Testing machine. Ingot turning facilities (c)
Detroit Steel Corp.	$ 5,100,000	.....	.....	.....	.....	.....	.....	.....	One flame scarfer (c). Four soaking pits (c)	One 156-in. welded wire fabric machine (c)

PARTIAL LISTINGS OF ANNOUNCED EXPANSION PLANS—1958 (CONTINUED)

Company and plant	Cost	Additional ingot capacity, tons	Steelmaking facilities	Additional iron capacity	Ore preparation	Hot mills	Cold mills	Finishing facilities	Heating furnaces and pits	Miscellaneous
Granite City Steel Co. Granite City, Ill.	$ 33,000,000	120,000	.....	.....	Sintering plant (c)	.....	Revamp cold tandem mill (c). Temper mill (c)	54-In. shear line (c)	14 Single stack annealing furnaces (c)	Three new buildings for coil storage, annealing, etc. (c). Oyxgen generator (c)
Gulf States Tube Corp. Rosenberg, Tex.	.....	.....	.....	.....	.....	12-Stand, 3-roll reducing mill	.....	.....	.....	.....
Inland Steel Co., Indiana Harbor, Ind.	.....	500,000	Seven open hearths improved (c)	.....	4000-Ton daily sintering plant. Ore bridge	46 x 90-In. universal slabbing mill (c). 76-In. hot strip mill improved (c). Wide flange structural mill improved.	Cold rolled sheet mill (c). One twin-stand temper mill.	One electrolytic tinning line. Additional facilities at 28-in. structural mill.	One continuous annealing line. 44-In. hot strip mill slab furnace (c). Three 76-in. hot strip mill slab furnaces (c). Two 28-in. structural mill reheating furnaces.	Office building (c). Two 87-oven coke batteries (c)
Interlake Iron Corp. Chicago, Ill.	.....	.....	.....	.....	.....	.....	.....	.....	.....	Expanded ore and dock facilities
Jones & Laughlin Steel Corp.	$150,000,000									
Aliquippa Works Div.		.....	.....	.....	Sinter plant	Continuous weld mill (c)	.....	.....	8 Soaking pits (c). Continuous annealing facilities.	.....
Cleveland Works Div.		.....	.....	.....	.....	Reversing rougher for hot strip mills (c)	.....	Shear line (c)	Hot scarfer	Oxygen generators (c). Sheet handling facilities.
Pittsburgh Works Div.		.....	.....	Enlarge one blast furnace (c)	.....	.....	.....	.....	.....	59 Coke oven battery.
Stainless & Strip Steel Div.										
Detroit, Mich.		.....	.....	.....	.....	.....	.....	Wire drawing (c)	.....	.....
Louisville, Ohio		.....	.....	.....	.....	.....	Sendzimir mill (c). 54-In. temper mill (c)	.....	Continuous annealing and pickling (c)	Shear lines (c)
Kaiser Steel Corp. Fontana, Calif.	$214,000,000	1,440,000	Three oxygen steelmaking furnaces	Fourth blast furnace	.....	New 86-in. independent hot strip mill (c). 46 x 90-in. slabbing mill (c). Conversion of 110-in. plate mill to 148-in. mill (c)	One temper mill (c)	Second electrolytic tinning line (c). 60-In. strip pickler (c)	Enlarging 22 70-ton soaking pits (c). Ten 120-ton soaking pits. One continuous annealer (c). Three slab heating furnaces (c)	90 Coke ovens
Napa, Calif.	($2,000,000)	.....	.....	.....	.....	.....	.....	Expansion of large pipe facilities	.....	.....
Keystone Steel & Wire Co. Peoria, Ill.	$ 4,100,000	.....	.....	.....	.....	Flying shear (c). Hot bed (c). Cooling bed (c)	.....	Wire drawing equipment (c)	Two soaking pits (c)	Power plant boiler (c)
Laclede Steel Corp. Alton, Ill.		.....	.....	.....	.....	Rebuilding and modernizing 10-in. skelp mill	.....	.....	.....	.....
Latrobe Steel Co. Latrobe, Pa.	.....	.....	Consumable electrode vacuum furnace	.....	.....	.....	.....	.....	.....	.....
Lone Star Steel Co. Lone Star, Texas	$ 8,000,000	150,000	Open hearth furnace (c)	.....	.....	Bar mill (c). Stretch reducing mill (c)	.....	.....	.....	.....
Lukens Steel Co. Coatesville, Pa.	$ 33,000,000	180,000	100-Ton electric steelmaking furnace	.....	.....	140-In. plate mill	.....	.....	Nine soaking pits (c). Additional soaking pits.	.....
McLouth Steel Corp. Gibralter, Mich.	$ 3,500,000	.....	.....	.....	.....	.....	.....	.....	16 Single stack annealing furnaces (c)	.....
Trenton, Mich.	$ 35,600,000	466,000	Two oxygen process vessels 85 tons each (c)	Second blast furnace. Capacity 675,250 tons	2000-Ton per day sintering plant (c)	.....	.....	.....	.....	Enlargement of power plant, gas cleaning system and air separation facilities (c

Company and plant	Cost	Additional ingot capacity, tons	Steelmaking facilities	Additional iron capacity	Ore preparation	Hot mills	Cold mills	Finishing facilities	Heating furnaces and pits	Miscellaneous
National Steel Corp. Great Lakes Steel Corp., Ecorse, Mich.	$ 40,000,000	200,000	Improve open hearths	Enlarge blast furnace (c)	12-Ft sinter plant (c)	One scale-breaker. One 4-high reversing rougher.	.....	.....	One slab heating furnace	Oxygen plant
Weirton Steel Co., Weirton, W. Va.			Oxygen lances	.....	12-Ft sinter plant (c)	.....	4-Stand tandem	Two electrolytic tin-coating lines. One 42-in. continuous galvanizing line (c). *One 48-in. lacquer and laminate line (*At Enamelstrip Corp., Allentown, Pa.)	Three continuous cleaning and annealing lines	Car unloader (c). Pure still (c).
Pittsburgh Coke & Chemical Co. Neville Island, Pa.	$ 3,000,000	.....	.....	Rebuild blast furnace for ferromanganese (c)	.....	.....	.....	.....	.....	No. 2 Battery of 35 coke ovens
Pittsburgh Steel Co.	$ 6,000,000	240,000	.....	.....	.....	30-In. 6-stand billet mill (c)	.....	.....	.....	.....
H. K. Porter Co. Inc. Connors Steel Div. Birmingham, Ala.	$ 460,000	30,000	.....	.....	.....	.....	.....	.....	.....	Pouring building. Two pouring cars
Huntington, W. Va.			.....	.....	.....	19-In., 3-high rougher. Two 16-in. roughers	.....	.....	Reheating furnace	.....
Republic Steel Corp. Chicago, Ill.	$ 18,000,000	.....	Three electric furnaces rebuilt (c)	.....	.....	11-In. bar mill (c)	.....	.....	.....	.....
Cleveland, Ohio	$ 2,000,000	.....	.....	.....	.....	.....	.....	60-In. zinc electro-plating line (c)	.....	Conveyor belt system
Gadsden, Ala.	.....	.....	.....	.....	.....	4-High, 112-in. reversing plate mill	.....	.....	.....	.....
Youngstown, Ohio	$ 1,300,000	.....	.....	.....	.....	Blooming mill stand	.....	.....	.....	.....
	$ 900,000				New sintering facilities					
	$ 432,000									Skelp cleaner. Two cutoff-machines
Sharon Steel Corp. Sharon, Pa.	$ 6,000,000	100,000	100-Ton electric furnace (c)	.....	.....	.....	.....	.....	.....	.....
Timken Roller Bearing Co. Canton, Ohio	$ 12,500,000									
	($ 500,000)	.....	Consumable electrode vacuum melting furnace (c)	.....	.....	.....	.....		.....	
	($ 585,000)							Bar stock finishing		Metallurgical laboratory. Stainless tubing facilities
Gambrinus Plant	($1,500,000)	.....	.....	.....	.....	Piercing mill	.....	.....	.....	
	($ 275,000)									Steel warehouse (c)
U.S. Pipe & Foundry Co. Birmingham, Ala.	.....	.....	.....	1000-ton per day blast furnace (c)	.....	.....	.....	.....	.....	.....
U. S. Steel Corp. Clairton Works, Clairton, Pa.	$665,000,000	.....	.....	.....	.....	40-In. bloomer electrification (c)	.....	.....	Three rows soaking pits (c)	Three batteries coke ovens (c). Tar distillation facilities
Duquesne Works, Duquesne, Pa.	.....	.....	83-Ton electric furnace (c)	.....	.....	46-In. 2-high reversing slabbing blooming mill. 36-In. blooming mill. 4-Stand, 21-in. billet mill	.....	.....	Seven banks soaking pits	Oxygen metallurgical laboratory (c)
Edgar Thomson Works Braddock, Pa.	.....	.....	.....	.....	Three sintering machines (c	.....	.....	.....	.....	.....
Gary Sheet & Tin Mill Gary, Ind.	.....	.....	.....	.....	.....	.....	Temper mill	Electrolytic tinning line (c). Pickling line	Continuous annealing line. Eight annealing furnaces.	.....
Gary Works Gary, Ind	.....	.....	.....	.....	Three sintering lines	44-In. slabbing mill. 160-In. plate mill improvement. 38-In. hot strip mill improvement	.....	.....	12 Banks soaking pits	.....
Homestead Works Munhall	.....	.....	Open hearth improvements	.....	.....	Improvements to 160-in. plate mill	.....	.....	Seven treatment furnaces. Three heating furnaces	.....
Ohio Works Youngstown, Ohio	.....	.....	.....	.....	5000-Ton per day ore sintering machine (c)	.....	.....	.....	.....	.....

PARTIAL LISTINGS OF ANNOUNCED EXPANSION PLANS—1958 (CONTINUED)

Company and plant	Cost	Additional ingot capacity, tons	Steelmaking facilities	Additional iron capacity	Ore preparation	Hot mills	Cold mills	Finishing facilities	Heating furnaces and pits	Miscellaneous
U. S. Steel Corp. (continued)										
South Works Chicago, Ill.	.....	.....	Open hearth improvements	.....	Sintering machine	46-In. blooming mill (c). Structural mill (c). Improvement to 96-In. plate mill	.....	.....	17 Banks soaking pits	.....
Columbia-Geneva Steel Div. Geneva Works Geneva, Utah	.....	.....	.....	.....	.....	.....	.....	.....	Two banks soaking pits (c)	.....
Pittsburg Works Pittsburg, Calif.	.....	.....	.....	.....	.....	.....	.....	Electrolytic tinning line (c)	Continuous annealing line	.....
National Tube Div. Lorain Works Lorain, Ohio	.....	.....	.....	.....	.....	.....	.....	Continuous buttweld mill	.....	.....
Tennessee Coal & Iron Div. Fairfield Works Fairfield, Ala.	.....	.....	.....	.....	Sintering machine	Plate mill improvements	Temper mill	54-In. pickling line	Continuous annealing line	One battery coke oven
Universal Cyclops Steel Corp. Bridgeville, Pa.	.....	.....	.....	.....	.....	.....	.....	.....	.....	Vacum degassing equipment (c)
Wallingford Steel Co. Wallingford, Conn.	.....	.....	.....	.....	.....	.....	27-In. sendzimir mill (c)	Bright annealing equipment	.....	.....
Wheeling Steel Corp. Benwood, W. Va.	$ 27,400,000	.....	.....	.....	.....	.....	.....	Consolidate pipe finishing (c)	.....	Pipe warehouse (c)
Steubenville, Ohio	.....	.....	.....	.....	.....	Revamp hot strip mill auxiliary (c)	.....	.....	.....	.....
Yorkville, Ohio	.....	.....	.....	.....	.....	.....	Revamp temper mill (c)	Cleaning line, revamp wash (c). Revamp pickling (c). Trimming line (c)	Portable annealing (c). Continuous annealing line	.....
Wisconsin Steel Div. International Harvester Co Chicago, Ill.	$ 12,800,000	.....	.....	.....	.....	New merchant bar mill	.....	.....	.....	Hot scarfing machine
Youngstown Sheet and Tube Co. Indiana Harbor	$ 98,000,000	125,000	.....	.....	4200-Ton per day sintering plant	.....	.....	.....	Billet reheating furnace (c). Slab reheating furnace (c). Continuous tin-plate annealing line (c). Second continuous annealing line	.....
Campbell Works Youngstown, Ohio	.....	125,000	.....	.....	.....	Modernization hot strip mill. Electrification blooming mill main drive (c)	.....	Sheet cut-to-length shear line	Three slab reheating furnaces	.....
Partial Totals	$1,565,141,000	4,420,000								

sheet and strip mills. The majority of these were completely new mills, others were rebuilds and improvements of existing units. In either case, the projects for the most part involved the latest advances in automation equipment.

In the steelmaking field there were eight new units, most of which were electric furnaces. Top-blown oxygen converters were important factors also, with a new steelmaking plant being completed on the west coast and another under construction in the Chicago district.

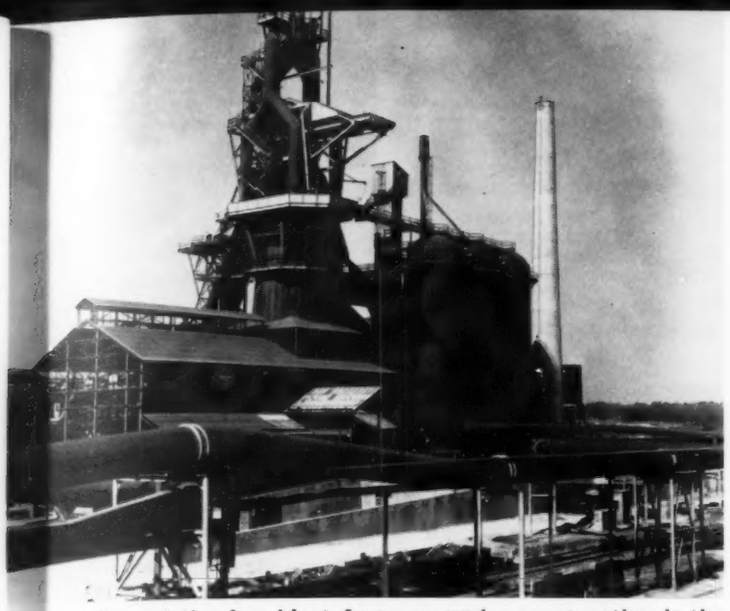
In the sintering field it was a record year for construction. Some 20,000,000 tons of new sintering capacity were completed which will in effect increase blast furnace capacity.

Five new continuous annealing lines were on the year's program. There were three new electrolytic tinplate lines, four coke oven batteries, several pipe mills, new batteries of soaking pits, etc.

This new equipment was of course accompanied by retirement of some obsolescent equipment. Among them were several bessemer converters and a steam-driven blooming mill drive.

Extensive work was under way on the part of several steel companies on new research facilities.

The attached table on expansion is an attempt to outline the status of some of the major programs. Unfortunately such a table is out of date as soon as it is prepared.



One of the few blast furnaces under construction is the fourth unit going in Kaiser's Fontana plant.

The information on this table has been obtained from company reports, official company releases, financial statements, discussions, etc. Only the major items are listed. Items listed are those either under construction or on the construction schedule for 1958. Items with a (c) after them were completed in 1958. Some other items without a (c) after them were undoubtedly also completed in 1958 since there is usually more pressure to release information on new projects than there is on completions. Some items are omitted because the information is not available.

When possible, items and costs are allocated against a plant location. Sometimes they are given as over-all generalized figures and cannot be allocated against a particular plant. Where figures are given in parentheses, they are breakdowns indicating the portion for the plant on the same line as the figure. Such figures are included in the over-all figures without parentheses given for that particular company or plant.

In most cases the figures included are only those which have been officially authorized. The partial totals of $1,565,141,000 and 4,420,000 tons of capacity are not complete figures since, in a number of cases, no cost or tonnage estimates have been released on some of the work under way. Increases in capacity due to minor improvements are usually not included. True totals are appreciably higher.

Nor can the cost and tonnages for this year be added to last year's report, since projects, which may be carried over from one year to another before completion, are listed in both years.

FOREIGN PLANTS

Although the pressure for additional steel capacity declined in the United States, in most other parts of the world there were constant efforts to increase basic capacity, flat product capacity and efficiency of operations. What is not too widely realized is that the steel industries in many foreign countries, even those based on free enterprise, have their future planning done for them on an over-all country-wide standpoint. Many countries are patterning their future efforts on plans similar to the Russian 5-year plans, and 5-year, 6-year and 7-year programs provide a basis on which most of these efforts are made.

In 1958, world steel production dropped to about 295,000,000 net tons vs 321,000,000 in 1957. Production in the United States was down appreciably. Production also dropped in Canada, Great Britain, West Germany and Japan. In Russia, on the other hand, output rose over 3,000,000 tons to 60,000,000 tons for 1958.

Since the war a number of countries have built or are planning to build their first steel plants. Among them are Pakistan, South Korea, Portugal, the Philippines, Israel, Colombia, Venezuela, Peru and Hawaii.

Steel production in Canada was markedly down during the year. Contributing heavily to this was the long drawn-out strike in the latter half of the year at Steel Company of Canada's Hamilton Works, which represents about half the steel capacity in Canada.

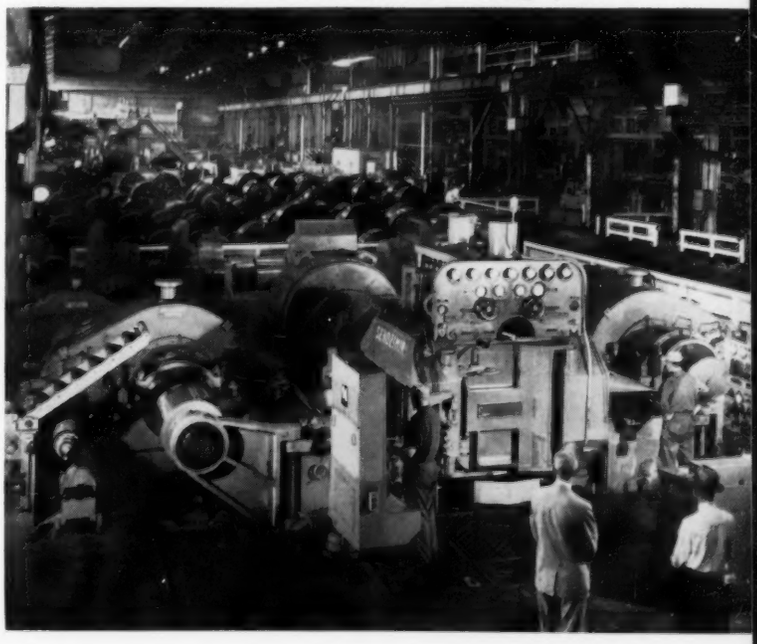
The Steel Company of Canada started operation on its new $25,000,000 46-in. high-lift blooming mill and 12 two-hole soaking pits at Hamilton. This is part of a $70,000,000 expansion program and will be followed by additional open hearth capacity, new plate mills and allied facilities. The blooming mill was so designed that it can be converted to a universal slabbing mill.

At Algoma Steel Corp. Ltd., a major construction program is under way. This includes a new 57-oven coke battery which will increase total coke producing capacity to 1,458,000 net tons per year. A new 20-ton capacity ore bridge was completed. No. 6 blast furnace was taken out for enlargement to a 27-ft diam hearth. This, along with a new boiler house and turboblower will increase iron producing capacity 1,500,000 tons a year.

Algoma also put an oxygen steelmaking plant into production late in the year. This unit consists of two 60-ton top-blown oxygen converters.

Also, the combination bar and strip mill was enlarged to permit production of flat rolled products up to 30 in. wide. New blooming and plate mills are scheduled for completion early in 1959. Supplementing these there will be nine new soaking pits and a new ingot stripper building. At Algoma Steel's Canadian Furnace Co. plant at Port Colborne, No. 2 blast furnace was dismantled and No. 1 was shut down for relining.

Allegheny Ludlum Steel Corp. brought a new 50-in. sendzimir cold mill in operation at the Brackenridge plant.



This 27-ft hearth diam blast furnace will be the largest ever built in Spain.

Dominion Foundry & Steel Ltd., Hamilton, Ontario, has announced an expansion of hot and cold rolling mill facilities. The four-high hot mill is to be widened to produce 60-in. strip, and a new down-coiler is to be installed. The 42-in. cold mill is to be speeded up and automatic gaging will be installed.

There was a great deal of interest in Canada over a proposal backed by A. V. Roe Canada Ltd., to build a $25,000,000 steel plate mill at Contrecoeur, near Montreal. This will be part of Dominion Steel & Coal Corp.

Puerto Rico's first steel mill, Industrial Siderurgica, Inc. set up an expansion program. This company started production on concrete reinforcing bars in the latter half of 1957. The additional work will increase bar-making capacity by some 50,000 tons annually. The plant has a rod mill and steel is produced in an electric furnace.

Under construction in Hawaii by Hawaiian Western Steel, Ltd. is a new steel plant to produce reinforcing bars. For the present, the plant will be a rolling mill using steel shipped from Canada and an electric furnace will melt local scrap. Estimated cost is $1,500,000. An eventual capacity of 25,000 tons per year is planned.

In a report prepared for the Mexican National Chamber of Iron & Steel Industries, it was estimated that Mexican steel production will climb up to 1,510,000 tons by 1961, more than double the 1957 production.

The Cia. Fundidora de Ferro y Acero de Monterrey, S.A., has completed a new plant to be run by a subsidiary, Aceros Planos de Monterrey, as part of its $65,000,000 modernization and expansion program. The new equipment includes a 66-in. hot strip finishing mill, a four-high reversing cold mill and skin pass mills. The company also plans to enlarge its basic annual capacity to 1,000,000 tons through the addition of new blast furnaces and seven open hearth furnaces.

Altos Hornos de Mexico at Monclova started up the first electrolytic tinning line in Mexico. The line has a maximum speed of 400 fpm and handles strip 18 to 38 in. wide and 0.0075 to 0.015 in. thick in coils weighing up to 22,500 lb. There is also a blooming mill and a 4-high reversing cold mill under construction.

A narrow hot mill for producing cotton baling strip went into operation during the year. This plant is being operated by Aceros de Chihuahua and is the first mill in Mexico to turn out this product.

The first steel mill in Panama, called Siderurgica Panama or the Panama Steel Co., went into operation late in the year. This plant will produce reinforcing steel bars and other small steel shapes. The metallics will come from scrap metal obtained locally. Capacity of the mill is about 8000 tons of reinforcing steel per year.

An American company was awarded a multi-million dollar construction contract for the Companhia Siderurgica Paulista (Cosipa) of Sao Paulo, Brazil. This project is located at Piacaguera, Brazil. It will include coal handling facilities, railroad, raw material supplies, sinter plant, 53 coke ovens, blast furnace, an oxygen-converter plant with two 60-ton converters, soaking pits, slab and plate mills, a 66-in. hot strip mill, continuous pickling line, a cold reducing mill and galvanizing equipment. The plant will have an initial annual capacity of 330,000 tons of rolled steel products.

The Brazilian National Steel Corp. at Volta Redonda, is installing a new three-stand tandem cold mill. Provision is being made for the addition of a fourth stand later. The new mill will have a total of 15,500 hp in the main drive system. At the start, the maximum strip speed will be 2610 fpm, which will increase to 3160 fpm with the fourth stand. Maximum strip width will be 48 in.

The Companhia Siderurgica Mannesmann, at Belo Horizonte, is building a plant with a steel capacity of 220,400 tons.

The expansion of the steel industry in Argentine is well under way. Extensive facilities will be located at the General Mamal N. Sonio plant at Punta Agerich, about 130 miles from Buenos Aires. This plant, when completed in 1961, will be the first integrated steel plant in Argentina and will have a capacity of over 660,000 tons of ingots per year. The total cost of the entire steel plant will be $300,000,000. The plant will be operated by Sociedad Mixta Metallurgia Argentina (Somisa) and will produce structural shapes, sheet and tubes.

The plant includes four 245-ton open hearth furnaces with waste heat boilers, 12 recuperative soaking pits arranged in six batteries of two holes each, and one continuous recuperative reheating furnace.

Another integrated iron and steel plant is being built for the Direccion General de Fabricaciones Militares of Argentina. Contracts were placed during the year for blast furnace equipment, steelmaking facilities and rolling mill equipment. The plant is located at Zapla, in Jujuy Province, about 1100 miles from Buenos Aires. The program contemplates replacing two 60-ton per day blast furnaces installed in 1945 with four blast furnaces having a daily output of 125 to 150 tons each. Iron will be processed in a combined basic bessemer and electric furnace shop, (three 15-ton converters, one 20-ton arc furnace) with a combined annual output of 150,000 tons. The plant will have a three-high blooming mill and

a three-high medium section mill. A light-section and wire-rod mill will be included later. Charcoal will be used in the blast furnace instead of coke, and will be produced from eucalyptus trees grown for this purpose.

Work in Chile by the Corporacion de Fomento de la Produccion continued on improving and expanding their steel plant, Compania de Acero del Pacifico.

The present program is aimed at improvement of hot strip production. This includes modification of the 32-in. blooming mill to a high-lift mill to enable edging work, a new 34 x 22 x 100-in. three-high roughing mill with vertical edger, a four-high reversing hot strip mill, a shearing line and a slitting and side-trimming line.

The program also includes a 220-ton open hearth furnace, a 55-ton-per-hr slab reheating furnace, additional cranes, a pickling line, a 21 and 53-in. x 48-in. three-stand tandem mill with provisions for a fourth stand, a four-high temper mill, annealing furnaces and miscellaneous auxiliaries.

When this program is completed, the plant will have an annual capacity of about 475,000 tons of steel ingots and 330,000 tons of finished products.

Steel output in Great Britain in 1958 is estimated at about 22,000,000 net tons compared with slightly over 24,000,000 tons in 1957. Pig iron production was about 14,800,000 tons, down some 1,200,000 tons from 1957.

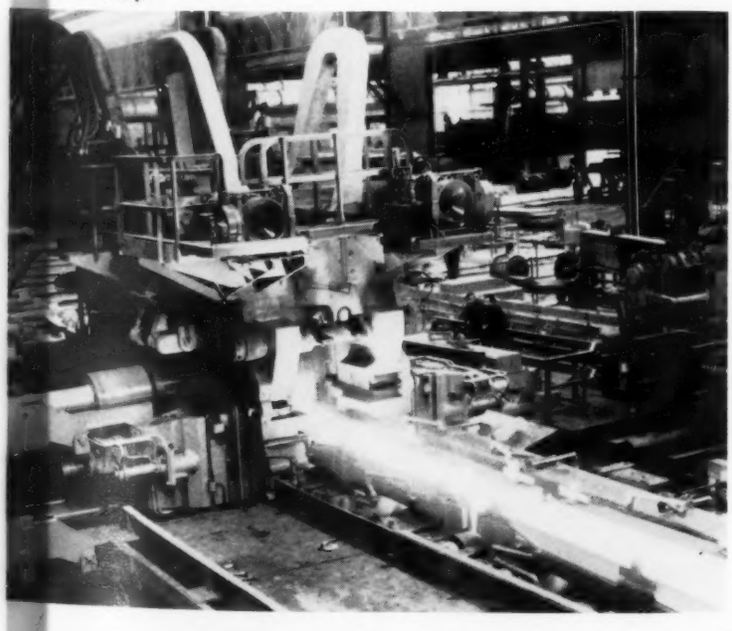
The British steel industry spent about $280,000,000 on modernization and improvements during the year.

Great Britain has one of the world's largest blast furnaces under construction at the Margam Works of the Steel Company of Wales. This unit will have a 31-ft hearth and will be rated at 1500 tons per day.

The newest and largest galvanizing line in Great Britain is designed to produce up to 10 tons per hr of either galvanized sheets or coil in a broad range of widths and thicknesses. This line is being installed at the Ebbw Vale works of Richard Thomas & Baldwins, Ltd. The line is designed to receive coils of strip up to 48-in. wide and 15 tons in weight.

In England the Lackenby Works of the Dorman Long & Co., Ltd., Middlesbrough, completed installation of a new rolling mill which will produce large commercial sizes of wide flanged beams. The mill is arranged to roll direct from the ingots. Beams up to 36 in. deep with 16½-in. flanges, 190 ft long and down to the smallest H-sections can be produced. Capacity is over 700,000 net tons annually.

Dorman-Long Co. put in a new rolling mill at the Lackenby works capable of rolling wide flange beams up to 36 in. deep.



A 144-in., 4-high plate mill was put into operation during the year at the Scunthorpe works of Appleby-Frodingham Steel Co., a branch of United Steel Companies, Ltd. The mill, driven by twin 4000-hp, d-c motors, replaces a 120-in. plate mill which was installed nearly 30 years ago.

Steel production in Germany dropped from 27,000,000 net tons in 1957 to an estimated 26,000,000 tons in 1958.

Steel production in France held up well, output in 1958 advancing six per cent to 16,000,000 tons. Iron output increased 1.5 per cent to 13,600,000 tons in 1958.

The steel industry of Germany, which was pretty well broken up after the war, is now in the process of regrouping. A number of merger programs are under discussion, some have actually been consummated and others are being planned. This is a return to the pre-war pattern.

One of the largest of the consolidation moves is a merger of August Thyssen Hutte A.G. with Phoenix Rheinrohr A.G. This would become Europe's largest steelmaker.

Another move was an absorption by Mannesmann A.G. of six of its subsidiaries into divisions or works.

In addition, Dortmund-Hoerder Huetteunion A.G., with a capacity of 2,800,000 tons, applied to the Coal and Steel Community to take over fifty-one per cent of the shares of Huttenwerke Siegerland plus Thyssen's share in the same company.

The Phoenix-Rheinrohr A.G. of Dusseldorf, West Germany, started construction of a $25,000,000 steel plant which will have three 70-ton oxygen converters. These units will replace two Thomas steel plants at Ruhrort.

In Spain, Empresa Siderurgica del Bierzo is going to install a low shaft blast furnace to use Almazcara and Coto Vivaldi ores. Also, the Manufacturas Metalicas Madrilenas started an iron and steel plant at Villaverde which has several 15-ton electric furnaces. A reversing strip mill also went into operation here during the year.

Portugal is starting construction of a new plant at Seixal, south of Lisbon. This plant will have an ingot capacity of 276,000 tons and will make light and medium bar mill sections. The plant is scheduled for completion early in 1961.

In Hungary, a second 25,000-cu ft blast furnace was put into operation at the Szatalinvaros Iron and Steel Works, about 60 miles south of Budapest. The new furnace will increase production at this plant by about 700 tons per day. A second battery of coke ovens is also to be built and hot and cold rolling mills are scheduled for completion by 1960.

Steel capacity in Russia as of the end of 1958 was probably just about 60,000,000 ingot tons. The Russians are making a tremendous drive to narrow the gap between their capacity and that of the United States. Under Khrushchev's new 7-year plan, 1959 to 1965, Russia is to increase its steel capacity to 100,000,000

ingot tons per year. Capital required will be more than $25,000,000,000.

The American delegation which visited the Russian steel industry in 1958 brought back interesting observations, some which were quite contrary to previous impressions. In addition to spectacular achievements actually observed, there were even more spectacular predictions for the future. The Russians talked of coke ovens with 50 per cent greater capacity than present ovens, of blast furnaces which would produce 5000 tons of iron per day, and of open hearths designed to produce 1000-ton heats.

More than 90 per cent of Russian steel is made in the open hearth. Emphasis is placed on getting production and the visitors' report on the 66 open hearth furnaces observed showed production rates of 20 to 41 net tons per hr.

In the Soviet Union open hearth operations are handicapped by shortages of fuel oil. Coke oven and blast furnace gas are generally substituted with faster firing of furnaces and, in some plants, with oxygen for combustion. Open hearth charges run about 65 per cent hot iron and 35 per cent scrap. Deep charges are used to increase the amount of steel produced in each heat. Large heats are tapped into two ladles, each having two stoppers.

The delegation estimated that Russian mills use from 25 to 50 per cent more manhours per ton of like product than the steel mills in the U. S. On the other hand they spend money extravagantly for machinery and equipment to eliminate any possible delay to production. Although high rates of production are achieved, the products in many cases were of a quality that would not meet American specifications.

A large project under way in Russia is one for the West Siberia Metal Works, about 10 miles west of the present steel plant at Stalinsk. This plant is scheduled to have four blast furnaces, 550-ton open hearths, bessemer converters, top-blown oxygen converters and equipment to produce hot and cold rolled strip, electric tinplate and structural sections. Operations at this plant are scheduled to start in 1960. Another large plant scheduled for completion in 1964 is the Karaganda Iron & Steel Works, which will be a completely integrated plant to produce hot and cold rolled sheet, strip and tinplate.

A third large unit is the Lake Baikal Steel Works located about 1200 miles east of Stalinsk which is to be started in 1959. This plant will have plate, sheet and structural production.

Each of these three plants are scheduled to have capacities of 4,000,000 tons or more.

Extensive work is also under way at other plants. Seven blast furnaces are scheduled for completion in 1958, all with 29.8-ft hearths, working volumes of 60,680 cu ft and carbon-lined hearths and boshes. Each furnace is expected to turn out 3000 tons per day.

After 1958 the Soviets plan to build furnaces with 34.4-ft hearths and working volume of 77,680 cu ft. These units are to have carbon hearths, carbon boshes and carbon in the stack 16 ft above the mantle. These units will have three stoves with automatic changing. The stock houses will have belt conveyors which will operate automatically. These furnaces are expected to produce 5000 tons a day.

Plans for blast furnace operation include use of 100 per cent self-fluxing sinter, oxygen enrichment, top pressure up to 22 psi, controlled humidity in the blast, blast temperatures up to 1830 F and completely automatic operation.

Steel production in 1958 in Russia was probably about 60,000,000 net tons and iron probably totalled about 42,000,000 net tons.

In July, Egypt's first integrated iron and steel works was inaugurated at Helwan. This plant is scheduled to produce 265,000 tons of ingots annually and will be increased to 500,000 tons later. The operator is the Egyptian Iron & Steel Co. (Societe Egyptienne pour le Fer et l'Acier or SOCEFA.) The first part of the works now completed consists of two blast furnaces, three basic converters, two electric furnaces, rolling mills and auxiliary plant.

A steel plant is being built at Teheran, Iran, for the L' Organization du Plan. This plant will have an annual capacity of 132,000 tons.

India is laying plans for a fourth government-owned steel plant in addition to the three now being built by the British, West Germans and Russians. With a capacity of 2,500,000 to 3,000,000 tons, it will be the biggest of the four.

By 1961 each of the three plants under construction in India will be producing about 1,000,000 tons. This, in addition to the production of privately-owned mills, will put steel output then at about 6,000,000 tons. Steel production in 1958 was about 1,900,000 tons. However, studies for the third five-year plan which runs from 1961 to 1966 predict production requirements up to 15,000,000 tons. To obtain this tonnage, further expansion will be required.

In Burma, an iron and steel plant went into production at Ywama, outside of Rangoon. Capacity is about 20,000 tons of ingot steel per year. Main components are electric furnaces and rolling mills for the production of light sections, rod and thin sheet.

At the Port Kembla Works in New South Wales, the Broken Hill Proprietary Co. Ltd. started up a 45 x 115 in. two-high reversing slabbing mill built by an American firm. The mill cost about $19,700,000. It has a capacity of about 2,000,000 tons of steel per year.

An extensive devlopment is under way at this works where over $224,000,000 has been spent since the end of the war. A large part of this has been to put the plant into the tinplate field.

Red China started on a second five-year program in 1958. Production target set in 1958 was 7,700,000 tons of steel and 8,800,000 tons of iron. New construction under way includes six blast furnaces and ten open hearth furnaces as well as rolling mill equipment in the Anshan area of Manchuria.

Even before the year was over, China was increasing its goal by fantastic limits. New plans call for doubling steel tonnage in a single year to 11,800,000 tons or double that produced in 1957. New production centers are located at Wuhan and Paotow. Small village and family blast furnaces are being built all over China.

In Korea a new open hearth shop for Dae Han Heavy Industry Co. of Seoul, will have a capacity of 166,000 tons.

Steel production in Japan in 1958 totaled 13,300,000 tons of ingot steel, down about four per cent from 1957.

Pig iron production in 1958 totaled about 8,200,000 tons, up eight per cent over 1957.

Some of the important developments in Japan during the year was an agreement made in March on joint Indian Japanese development of an iron ore mine at Rourkela, India with Indian capital of $17,000,000, Japanese capital of $8,000,000. In addition, $20,000,000 of capital is being furnished by the United States. When completed the development will produce 2,300,000 tons of ore on and after 1964.

Japan increased its effort on exports because of the decrease in domestic requirement for steel, and exports for 1958 totaled about 2,000,000 tons compared with 1,200,000 tons in 1957.

Since Japan must seek iron ore at longer distances, they have started an extensive shipbuilding program and five 15,000-ton ore carriers are to be built. A very heavy equipment program is under way and the Japanese steel industry spent in 1958 some 111,000,000,000 yen or about $310,000,000. The investment in 1959 will be about the same as in 1958.

The Japanese steel industry is in the middle of what they call their second rationalization program. This started in 1956 and will be carried out at an estimated cost of $1,500,000,000. The aim of this program is to increase production capacity, not only by expansion and renovation of equipment, but by constructing new integrated plants of modern design at new sites. Under the program in 1962, the Japanese steel industry will have some 12,500,000 tons of pig iron and 20,000,000 tons of ingot steel capacity. In this program there are ten blast furnaces with daily capacities of 1200 to 1500 tons and 15 converters (of which four are now in operation) to be installed by 1962. The program also includes installation of five blooming mills, four continuous hot strip mills, a continuous cold strip mill, seven reversing cold strip mills, seven sendzimir cold strip mills and a 4-high plate mill. Table I gives some additional details.

Loans from the Export-Import bank of Washington and the World Bank are playing an important part in this program. The World Bank loaned Kawasaki Steel Corp. $8,000,000; Sumitomo Metal Industries $33,000,000; Kobe Steel Wrks $10,000,000; and Nippon Kokan K.K. some $22,000,000. The Export-Import Bank of Washington loaned Yawata Iron and Steel Co. $26,000,000; Toyo Kohan Co. $71,000,000.

Of steelmaking capacity in 1962, 12,080,000 tons will come from open hearth furnaces, 4,770,000 tons from converters, and 3,300,000 tons from electric furnaces.

At the beginning of 1958 there were four blast furnaces under construction in Japan with a capacity of 1,090,000 tons. At the beginning of 1958, total blast furnace capacity stood at 7,790,000 tons from 31 furnaces.

At the beginning of 1958 open hearth steelmaking capacity totaled 9,800,000 tons from 150 furnaces. There were two more open hearth furnaces under construction but the trend seems to be to the oxygen converter. Two 50-ton oxygen converters with an annual capacity of 450,000 tons were in production at the start of the year, and in 1958 four more were built.

The Yawata Iron and Steel Co. has several 1500-ton blast furnaces now under construction for its Tobata area plant. One of these units started during the summer 1958. This will be the largest blast furnace in Japan, measuring 29 meters in height and 8.5 meters in diameter. It has three hot stoves.

TABLE I

SECOND MODERNIZATION PROGRAM

JAPAN 1955–1962

Company	Description	Estimated cost	Completion
YAWATA IRON & STEEL			
Tobata Works	Two 1500-ton blast furnaces	$47,000,000	
	Two batteries coke ovens	12,900,000	
	Two 60-ton converters	25,000,000	
	Blooming mill	9,700,000	
	80-In. semi-continuous hot strip mill	25,000,000	October, 1958
	Deep drawing sheet mill	4,200,000	
	Sintering plant (3500 ton per day)		
Yawata Works	Blooming mill	6,050,000	
	Plate mill	23,000,000	
	Two 50-ton converters	13,300,000	
FUJI IRON & STEEL			
Muroran Works	Sintering plant (1000 tons per day)		September, 1957
	Two blast furnaces repaired		September, 1959
	Blooming mill	9,000,000	March, 1960
	56-in. hot strip mill	22,400,000	September, 1957
	56-in. cold strip mill		November, 1958
Kamaishi Works	Remodeling large section mill	5,000,000	November, 1958
	Expand two blast furnaces from 700 to 900 tons per day		November, 1960
Hirohata Works	1500-ton blast furnace	15,200,000	March, 1960
	Two 40-ton converters	12,600,000	December, 1959
	160-in. plate mill		September, 1958
	Plate mill	14,000,000	March, 1960
	Blooming mill		March, 1983
	Electrolytic tin plating line	5,100,000	March, 1958
	Cold mill		March, 1959
JAPANESE STEEL & TUBE CORP.			
Nippon Kokan Kabashiki Kaisha Kawasaki Works	No. 5 coke oven		March, 1959
	1000-Ton blast furnace restored	7,000,000	March, 1958
	Two 45-ton converters	9,000,000	January, 1958
	Seamless tube mill	15,700,000	March, 1959
	Seamless tube mill		December, 1957
	Welded pipe mill	5,000,000	September, 1957
Mizue Works	Two 60-ton converters	17,800,000	March, 1959
	Blooming mill	11,500,000	March, 1959
	68-in. hot strip mill	22,000,000	March, 1959
	Reversing mill	8,400,000	March, 1959
SUMITOMO METAL INDUSTRIES			
Wakayama Works	Remodel Steifel Mannesmann mill		
	1000-ton blast furnace	3,220,000	
Kokura Works	Remodel blast furnace from 350 to 650 tons	7,800,000	January, 1958
	Wire and rod mill repair	2,000,000	August, 1958
KAWASAKI STEEL CORP.			
Chiba plant	One 1000-ton blast furnace		March, 1958
	56-in. semi-continuous hot strip mill	45,000,000	April, 1958
	56-in. cold strip mill		May, 1958
KOBE STEEL WORKS	600-ton blast furnace	11,000,000	January, 1959
NAKAYAMA STEEL WORKS	Hot strip mill	2,800,000	
	Reversing mill	2,300,000	
	Converter	3,400,000	
NIHON TEPPAN AMAGASAKI IRON & STEEL MFG.	Sendzimir mill	4,400,000	
	Blast furnace	6,400,000	
NICHIA STEEL	Remodeling hot strip mill	4,200,000	
	Installing reversing mill	3,900,000	
TOYO KOHAN	Cold strip mill	12,300,000	
	Electrolytic tinning equipment		
YODOGAWA STEEL WORKS	Cold reversing mill	4,200,000	
AMAGASAKI STEEL WORKS	Two 30-ton converters	11,500,000	
	3-high plate mill	5,000,000	

Yawata also ordered from the United States a six-stand, 4-high finishing train for their 80-in. hot strip mill, a 4-high reversing cold reduction mill, and equipment for altering an existing tandem cold mill for rolling sheet products. The installations will be made at the Tobata Works on Kusha Island.

The Fuji Iron & Steel Co. put into operation a 160-in., four-high reversing plate mill at their Hirohata Works. The mill will have an annual capacity of 700,000 tons.

The Hikari Works of Nippon Tokushu Steel Tube Co. Ltd. started production in August on a medium-diameter electric resistance weld tube mill. A small diameter tube mill is also under construction. The product from the newly completed mill will vary in size from 4 to 14 in. and will have an annual capacity of 120,000 tons.

Construction was also completed on an electric re-

sistance weld pipe mill under construction for Sanki Kogyo Co. Annual capacity is estimated at 60,000 tons per year of varied sizes from 4½ to 12.75 in.

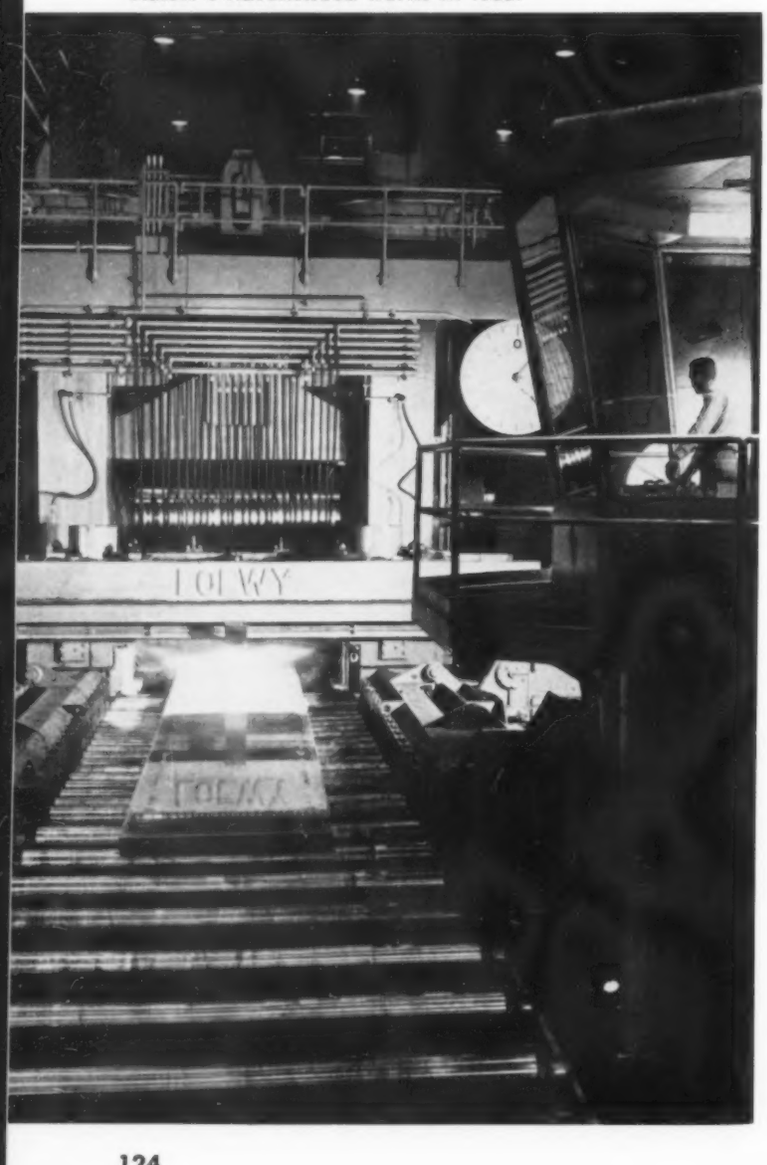
A new automatic rolling mill has been ordered from the United States by Nippon Kokan K.K. for the Mizue Works at Tokyo. This is a new 68-in. semi-continuous hot strip mill which will include a two-high scalebreaker, a four-high universal reversing roughing mill with front and rear tables, rotary crop shear, scalebreaking pinch rolls, five 68-in. four-high hot mill finishing stands, two hot-strip downcoilers with double coil transfers, descaling systems and lubrication systems.

The four-high universal roughing mill will be automatically controlled by the first overseas application of a programmed digital card system. Any rolling schedule up to nine passes may be preselected with screwdown adjustments for horizontal and edger rolls, and mill reversals automatically controlled. The mill is scheduled for completion in 1959 and will be capable of rolling hot carbon steel strip from 0.063 to 0.236 in. thick at delivery speeds up to 2200 fpm.

The Sumitomo Metal Industries, Ltd., is planning an expenditure of $83,000,000 to increase its capacity to about 825,000 tons of pig iron, 1,500,000 tons of steel ingots, and 1,300,000 tons of finished steel products. Completion is scheduled for early in 1962.

The Sumitomo Metal Industries, Ltd. put into operation a new wire rod mill at the Kokura Steel Works in August.

A 110-in. reversing mill started aluminum production at Kaiser's Ravenswood works in 1958.



RAW MATERIALS

The extended period of reduced operations in the steel industry solved the raw materials situation for the time being, and raw material supplies presented no problems. As a result, raw materials suppliers who were geared for expanded operations found it necessary to cut back on their own operations. Some of this was reflected in price reductions. Toward the end of the year, the increasing tempo of steel production put some supplier units back into operation, and there were some price increases, particularly in such materials as copper, zinc and lead.

Despite the lack of pressure on raw material supplies, there was constant work under way in some fields on development of new resources. This was particularly true for iron ore.

One rather dismal forecast was made by the Chief of the Foreign Activities Division of the United States Bureau of Mines who predicts that by 1970 it will be necessary for the United States to import more than 40 per cent of its ores. He pointed out that India and Brazil have most of the world's high grade iron ore, and Russia is the only world power who can produce all its own ferroalloys. He also pointed out that although the United States has good coking coals, China has the world's third best supply.

Movement of iron ore down the Great Lakes ended early in December. The total was about 53,000,000 gross tons, almost 40 per cent less than 1957 shipments of slightly over 84,800,000 tons. The 1958 movement is the smallest since 1939.

Iron ore stocks at the docks were some of the highest in history and on Oct. 31, 1958, totaled 71,700,000 gross tons—about eight months' supply. This was over 3,000,000 tons more than at the same time in 1957.

Total shipments of iron ore to the United States consumers in 1958 were around 90,000,000 gross tons, down over 30 per cent from the 137,100,000 gross tons a year ago. While imports of ore decreased during the year, the drop was much less severe than the Great Lakes shipments. About 26,000,000 tons were imported including ore from Canada. This is a drop of 20 per cent. Foreign ores are growing in favor because they are higher in iron content and are also cheaper to produce.

In 1957 over 88 per cent of the domestic and Canadian iron ore shipped to steelmakers was beneficiated which includes screening and crushing. In 1958 this percentage was still higher.

One of the largest ore developments under way in Canada is being sponsored by U. S. Steel in their Quebec Cartier development in North Central Quebec. This program includes a 193-mile railroad and a 60,000-hp hydroelectric plant. When completed the new mine should produce about 8,000,000 tons of iron ore concentrates a year from a low grade, easily beneficiated ore which runs about 30 per cent Fe. The concentrated product will run 62 Fe or more. Estimated cost of this project is from $200,000,000 to $300,000,000.

There are a number of other projects being developed. The Pickands Mather Co. expected to be in production in 1958 with a mining-beneficiation plant known as the Hilton Mine on the Ottawa River in Quebec. A production of 600,000 to 750,000 tons of pellet a year is expected. M.A. Hanna Co. is building a beneficiation plant at Moose Mountain, Ont. Plans are for initial production of 500,000 tons of concentrates a year.

In the Labrador trough, a company called the Ungava Iron Ores hopes to begin construction in the summer of 1959, with production starting in 1963 of 500,000 tons of ore. About $100,000,000 will be needed to get the first units operating. By 1968 production capacity should be up to about 6,000,000 tons a year.

Jones & Laughlin Steel Corp. exercised an option to lease 5640 acres of iron ore property in the Mt. Wright area of Northern Quebec. J&L has proved about 1,000,000,000 tons of crude ore which will make 335,000,000 tons of iron concentrates. The corporation has no plans for immediate development of this area which is owned by the Quebec Cobalt and Exploration, Ltd.

It was reported during the year that a new iron ore deposit has been found under Kingston Harbor. Estimated reserves are 100,000,000 tons of iron ore. A dispute on ownership may hold up development of project.

One of the new ore developments in this country, located at Pea Ridge near St. Louis, Mo., is a $35,000,000 project sponsored by Bethlehem Steel Co. and St. Joseph Lead Co. through the jointly formed Meramec Mining Co. This is one of the few finds of ore in substantial quantities in the United States for some time.

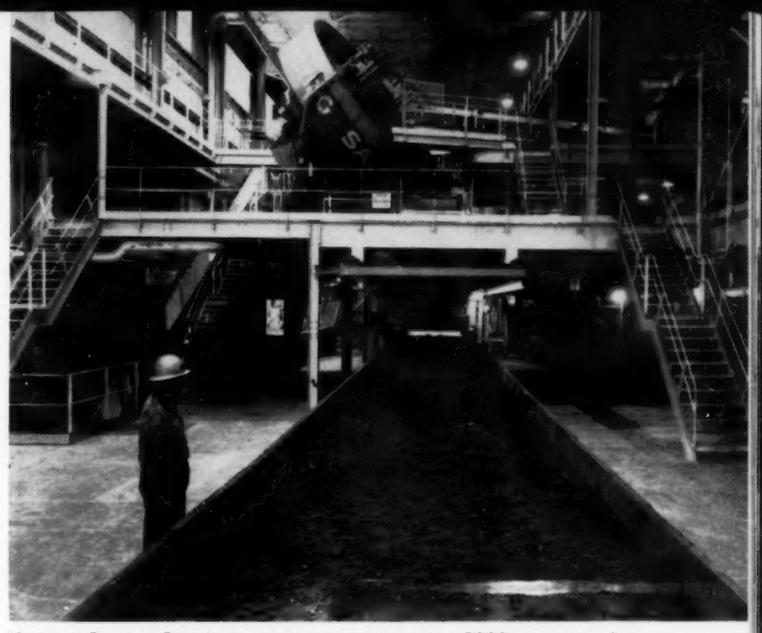
It is expected that Bethlehem will build a 6000-ton per day pelletizing plant to concentrate 55 per cent Fe ore to about 65 per cent. At least 100,000,000 tons of reserves are in this area. The ore has a fairly high silicon content and about one per cent phosphorus, but with fine grinding can be relatively easily upgraded. The deposit is relatively deep and will require shaft mining.

Late in 1958 Bethlehem started up their Grace Mine ore development near Reading, Pa.

The M. A. Hanna Co. announced that they will undertake an extensive ore development in Brazil near the Belo Horizonte ore fields. Iron content of the ore as-mined is said to be from 60 to 70 per cent. Extensive study will be needed to determine if the ore can be mined and shipped competitively. To develop the body, a 300-mile railroad and a dock will be needed. M. A. Hanna went into this area by acquiring control of the St. John d'el Rey Mining Co., which has been operating the largest gold mine in Brazil and has large holdings of high grade iron ore reserves.

An unusual ore separation device involves the principle of high tension separation, a method which has been successfully used with a number of nonferrous ores, particularly for titanium, columbian and tin. The process is dry, which is particularly advantageous in locations where freezing may be a problem.

In the process, pulverized raw ore is dropped down over a rotating roll against which there is a corona discharge from a high voltage source parallel to the roll and a short distance away from it. As the raw ore dropping on the roll goes through the corona discharge, the more nonconductive material is repelled and diverted into the bins containing the gangue. The iron ore, which is more conductive, is not repelled but drops on to a conveyor or into bins. Voltages of 40,000 to 50,000 are used, and the rotational speed of the drum is varied to effect various kinds of separation.



United States Steel started operation of a 5000-ton per day sinter plant in the Youngstown district.

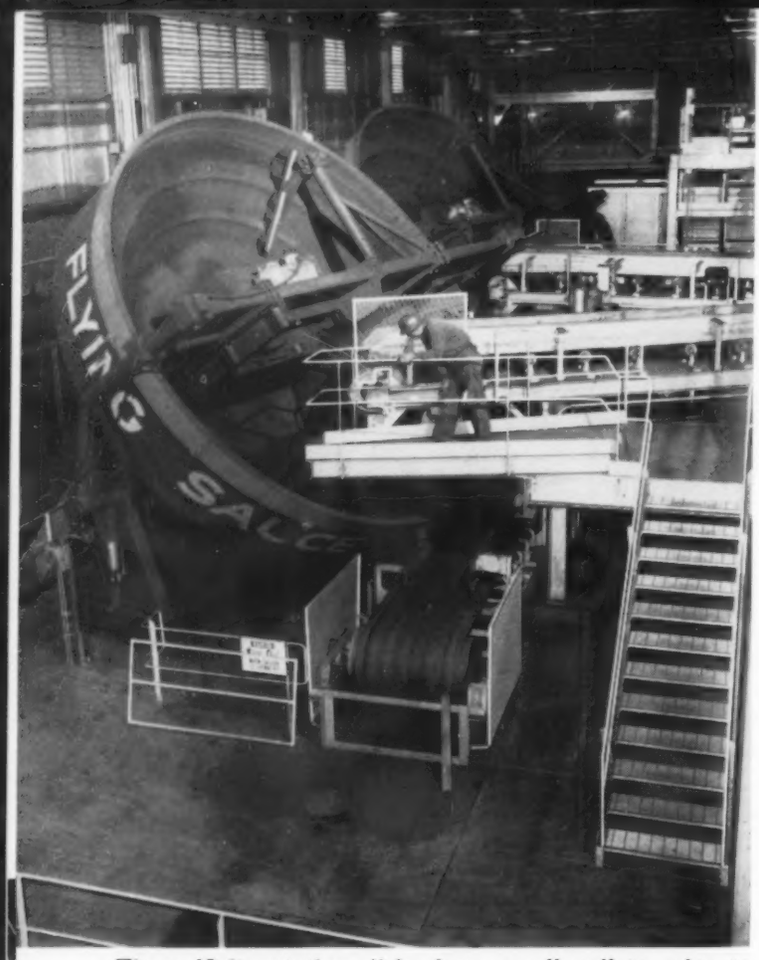
The production cycle may incorporate recycling of middlings to suit various ore supplies and finished product requirements. The process can take ores with iron content as low as 26 per cent and beneficiate these up to better than 68 per cent iron. It is claimed that the process can be operated at a separation cost in the order of 4¢ a ton.

Although high voltages are used, the current is small, in the range of 20 milliamperes. Current requirements are estimated at about one kwhr per 100 tons of product for the high voltage portion of the equipment. The current needed to operate the rolls, etc., is much greater than this.

Single units can handle up to 100 tons per hour and a large installation would involve the use of various combinations or batteries of units. It is estimated that a high tension separator installation with product capacity of 200 tons per hour would cost several million dollars. The final product is a powder which would require agglomeration for blast furnace use.

At the end of the year, scrap prices were on the decline, falling as low as $40 for No. 1 heavy melting scrap and $29 for No. 2 heavy melting. This probably reflected a belief that steelmaking operations would continue along at about the present trend for some time to come, as there are few indicators on steel production more sensitive than that of scrap prices.

A new process for scrap preparation has been extensively tried by Armco at its Houston plant. It is claimed that the percentage of steel yield from this scrap is up in the 90 per cent bracket instead of the 75 to 80 per cent available in No. 2 bundled scrap. The process is a secret one. However, in the process the operator can start with an automobile at one end of a conveyor and receive scrap ready for melting at the other end. Other material such as automobile door handles, brass, copper, wire, glass, wood, etc., are separated and flow into a rubbish hopper. It is estimated



These 18-ft rotating disks form small pellets prior to sintering at U.S. Steel's Youngstown plant.

the plant can produce from 500 to 1000 tons of processed scrap per day.

A new supplier for ferromanganese went into production during the year when Pittsburgh Coke & Chemical Co. made their first production run from their revamped Neville Island, Pa., blast furnace. This made the company the second non-captive blast furnace producer of ferromanganese in the United States. The adaption of the company's "A" furnace for the production of ferromanganese in addition to pig iron was accomplished at a cost of about $2,500,000, half of which went for a specialized gas cleaning system for the prevention of air and stream pollution. This furnace has a 22-ft hearth and is rated at 900 tons per day of pig iron, 400 tons per day of ferromanganese or 600 tons per day of spiegeleisen.

The free world attained a new high in annual nickel production capacity in 1958, estimated at 525,000,000 lb. Total nickel consumption in the free world in 1958 was about 330,000,000 lb compared with 415,000,000 lb in 1957. Despite this fact, annual nickel capacity is still on the increase and it is expected to go up to 550,000,000 lb in 1959, 600,000,000 lb in 1960 and 650,000,000 lb in 1961.

By 1961 International Nickel will have a productive capacity of 75,000,000 lb at its new plant in Manitoba and 310,000,000 lb in the Sudbury District of Ontario. At this time, Falconbridge Nickel Mines, Ltd., will have a capacity of 55,000,000 lb and Sherritt Gordon Mines, Ltd., will have 27,500,000 lb. In 1961 also, capacity in the United States Government-owned plant at Nicaro, Cuba, will be 54,000,000 lb of nickel from its deposits at Moa Bay, Cuba. In addition, there will be some 20,000,000 lb capacity largely from Riddle, Ore. The supply from New Caledonia by that time will be up to 50,000,000 lb.

Nickel production, as opposed to capacity, was cut back very markedly by the International Nickel Co. of Canada during the year. These cuts brought down the production rate to an annual basis of 200,000,000 lb from the 1958 peak rate of 310,000,000 lb.

The first break in the price of primary aluminum in 17 years came early in the year. A cut of 2¢ a lb by Aluminium, Ltd., in Canada was followed by similar reductions in the United States, which brought the price of pig aluminum to 24¢ a lb. This cut was partially offset later in the year when new wage increases caused prices to rise again, with pig going to 24.7¢ a lb. The initial reduction in price was due to dumping of aluminum by Russia at relatively low prices. Aluminum shipments in 1958 totaled 1,800,000 tons compared with 1,925,000 tons in 1957. Production in 1958 was about 1,550,000 tons. Current United States capacity for aluminum is 2,150,000 tons.

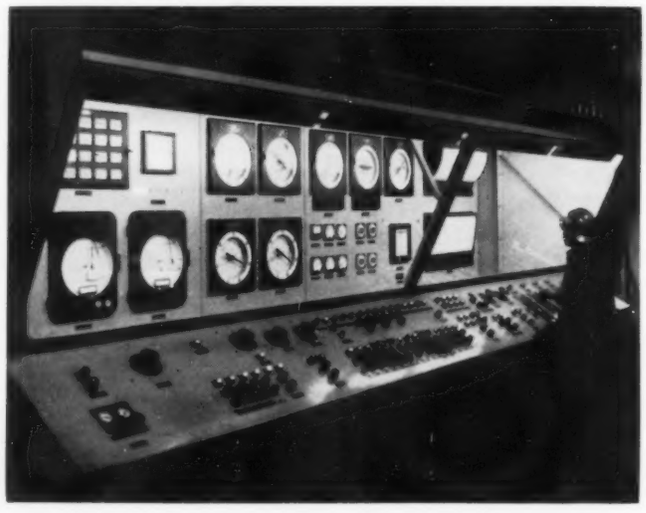
The Aluminum Company of America cut back its production of aluminum in 1958. Nevertheless, it continued its expansion program. Two new potlines at Massena, N. Y., went into operation with an initial total capacity of 108,000,000 lb of aluminum per year. Four small obsolete potlines with an annual capacity of 55,000,000 lb per year were permanently shut down.

The $200,000,000 Ravenswood Works of Kaiser Aluminum & Chemical Corp. became a fully integrated aluminum production and fabrication center during the year. One of the major units put into operation is a hot rolling line which includes a 168-in. reversing mill designed to break down 10,000-lb ingots. Next is a 110-in. reversing mill and then a continuous five-stand tandem mill from which coils emerge at speeds up to 1250 fpm. Still to be installed at Ravenswood are additional cold rolling equipment and heat-treating facilities. Upon completion, the Ravenswood mill will have an annual capacity of 170,000 tons.

Two of the four potlines of the Ravenswood reduction plant are also in operation with a current capacity of 72,500 tons of primary aluminum.

One of the world's widest aluminum foil mills is also in operation at Ravenswood. This mill is 72 in. wide and

Centralized control features new ore preparation facilities.



is designed to finish foil up to 66 in. wide. Maximum entry gage of the mill is 0.008 in. and it can roll foil down to 0.00025 in. by doubling. Other foil mills in production are a light gage sheet mill and two 60-in. foil mills.

The Ormet Corp., which will be the nation's fourth largest aluminum producer, started production. Two units started operation in the $55,000,000 Burnside, La., plant which will produce alumina. This plant has an output of 345,000 tons per year. Ormet's second production facility, a $110,000,000-aluminum reduction plant near Clarington, Ohio, is also in operation, with a capacity of 180,000 tons of primary aluminum per year. Ormet is owned by Olin Mathieson Chemical Corp. and Revere Copper and Brass, Inc. The aluminum will be shipped to these companies for fabrication.

In an effort to bolster domestic production, the United States Government set up import quotas on zinc which amounted to about 140,000 tons a year of zinc metal. Productive capacity for zinc in the United States is probably close to 5,000,000 tons annually.

Annual capacity for the production of titanium was about 32,000 tons of sponge and 16,000 tons of products. However, sponge producers operated at very low rates during the year, and a number stopped production. Cramet, Inc., which was owned by Republic Steel Corp. and Crane Corp. went out of production completely and turned the 6000-ton per year plant over to the Government.

BLAST FURNACES

Despite much written on developments in direct reduction processes, the blast furnace is still king. Nothing which developed during the year indicated that the blast furnace had anything to fear from any of the new processes for some time.

In unusual locations, far from sources of the usual materials for the blast furnace, there may be possibilities for direct reduction. However, for the bulk of production, the modern blast furnace will remain the unrivaled producer.

An important factor is that the blast furnace is not standing still. Continued efforts throughout the steel industry are seeing to it that the additional iron which will be needed will be obtained from existing blast furnace units, primarily through better preparation of raw materials. Investment of funds in ore preparation is, under present conditions, the economical way of increasing iron production.

The efforts of the steel industry during the year were to install sinter plants. Emphasis is now being made on additional sintering units to make self-fluxing sinter. Efforts are also being made to automate certain portions of the blast furnace. Computers are being set up for analysis, programming and charging.

Also, as furnaces are being rebuilt, they are being enlarged and methods reported in previous development stories are being applied, such as the use of oxygen, moisture, higher top pressure and higher blast temperatures. All this points to increased production from the existing units.

A typical example is U. S. Steel's No. 3 Gary furnace. This furnace had been out of production for over a year. The hearth diameter of this furnace was previously 26 ft and the rated capacity was 430,400 net tons annually. The furnace was rebuilt to a 28-ft hearth diam and a rated capacity of 499,100 tons per yr. Modern control apparatus was installed on the furnace, including such features as automatic wind proportioning to each of the 20 tuyeres. In addition, automatic stove changing control was installed. The furnace was also equipped with a three-stage gas cleaning system consisting of a dry dust catcher, a gas washer and an electric precipitator.

It is estimated that about 20,000,000 annual tons of sinter capacity were added in 1958. When the present program is completed, sintering capacity in United States plants will be about 64,000,000 tons a year and enable the country's blast furnaces to operate at full capacity on a 50 per cent sinter burden.

There were some 16 major sintering plants either under construction or completed during the year. These include: three 5000-ton per day plants for U. S. Steel at Houseville scheduled for completion in 1958, three 5000-ton per day plants for U. S. Steel at Gary scheduled for completion in 1958, one 5000-ton per day plant at Youngstown and one 5000-ton per day unit at the South Works. Weirton Steel Co. finished one 6000-ton per day plant in 1958. Jones & Laughlin Steel Corp. authorized a new 6000-ton per day plant for the Aliquippa Works scheduled for completion in 1960. Armco completed a 2400-ton per day plant at Ashland, Ky., Great Lakes Steel Corp. completed a 7000-ton per day plant at Detroit. Inland Steel Co. has a 4000-ton per day plant at Indiana Harbor scheduled for completion in 1959, and Youngstown Sheet and Tube Co. has a 4000-ton per day plant scheduled for production in 1959. McLouth Steel Corp. completed a 2000-ton per day plant at Trenton, Mich. in 1958 and Granite City Steel completed a 2000-ton per day plant.

The Weirton unit, one of the largest sintering plants in the steel industry, went into operation in July. This sintering machine has a bed 12 ft wide and 147 ft long. Later in the year, a slightly larger machine went into operation at the Great Lakes Steel Corp. of National Steel. This unit is also 12 ft wide but 153 ft. long.

The Weirton plant can produce 3½ tons per sq ft of hearth area per day and includes many new features such as a radiant type furnace for firing the mix. There are 14 double wind boxes with two fans which draw the heated air down through the sinter bed. Many design features of this plant are intended to combat air and river pollution. Water from the dust collectors is treated in thickeners.

Sinter from this line goes through a pallet type air sinter cooler 10 ft wide x 147 ft long, which cools the sinter to a temperature below 200 F. It has 14 windboxes and two fans, each rated 258,000 cfm.

One unit in U. S. Steel's sintering program, a plant at the Youngstown Works, was dedicated on June 12. At this plant, automatic proportioning is used to initially mix the ore and coal fires. The mix then goes to so-called "flying saucers," where it is continuously churned with controlled water additions, forming small pellets. The pellets spill constantly from the lip of the saucer and are spread with other ingredients of the sinter mix on the pallets forming the hearth. When the

sinter leaves the machine, it is broken up, screened and passed to a parallel cooling line where the fans drop the temperature from 1100 to 250 F.

A feature of this plant is an electronic control panel, complete with TV screens which give the operator continuous pictures. This panel also brings into the hands of one man all the process controls for the entire sintering plant.

The sintering plant which Jones & Laughlin Steel Corp. put into operation at their Cleveland Works in 1957 is a conventional traveling grate type, 8 ft wide and 128 ft long. The sinter from this plant is air-cooled in a circular 65-ft diam cooler.

The new sinter line at Aliquippa will be 13 ft-2 in. wide by 186 ft long, making it the largest sinter plant in the world. It will have a capacity of about 8500 tons of regular sinter and about 6500 tons of self-fluxing sinter.

In the Armco plant, a balling drum forms the mixture into loose pellets. These are fed onto a traveling grate up to a maximum depth of 13½ in. which moves first through an ignition furnace and down the open line. The line is 8 ft-3 in. wide, 97 ft long and has a hearth area of 807 sq ft. This machine has 85 cast iron pallets, 15 wind boxes, three separate dust collector systems and a roll-type feed system. Feed for the line is Labrador ore fines and a stock pile of flue dust at the plant.

The burden in the blast furnace apparently remains stratified down to the molten area as indicated by material frozen in a test furnace.

One feature of the Armco sinter installation is the breaker designed to reduce sinter to a size of minus 6 in. It consists of a six-sided shaft onto which are mounted renewable hubs and breaker arms. The breaker arms break the sinter cake through grizzly bars spaced to produce the desired size. These arms are made of 4-in. mild steel plate, hard surfaced at the cutting nose. A bull gear at the end of the breaker shaft is driven by a reducer powered by a 30-hp motor. Speed of the breaker arm shaft is approximately five rpm.

Although Inland Steel Co.'s newest sinter machine is rated at 4000-tons per day, the design of its elements was liberal, so it is expected that the nominal rating will be exceeded by a wide margin. The circular cooler has a mean diameter of 80 ft and a capacity of 8400 net tons per day.

Youngstown Sheet and Tube Co. broke ground on March 27 for a new sintering plant at the Indiana Harbor Works. The plant is designed so output can be doubled later with additional equipment. Some of the features of the plant are ore screening equipment, dust collectors, television system, automatic mixing, sensing and logging devices for controlling sinter mixes, scales for weighing materials conveyed through the operation. The machine will have a hearth area of 1344 sq ft.

Republic Steel completed a $900,000 expansion of its sintering facilities at the Youngstown plant, which raised monthly capacity from 22,000 to 40,000 tons.

The Russians report that changing from a burden of 20 per cent regular sinter plus 20 per cent self-fluxing sinter to 85 per cent self-fluxing sinter increased iron tonnage 14 per cent and reduced the coke rate 11 per cent. Self-fluxing sinter is weaker than a normal sinter, so it is sometimes necessary to use elevated top pressure when this material is used as a charge.

One of the earlier users of self-fluxing sinters on this continent is the Steel Co. of Canada, which has been operating or experimenting with dolomite fines in the sinter mix since April, 1956. Their operations have shown that the best performances are obtained with 18 per cent dolomite fines in the sinter mixture. Production rates are 8½ per cent higher when using dolomite sinter than with regular blast furnace sinter and the coke rates are 6½ per cent lower.

A paper presented during the year by the director of research of the Swedish Iron & Steel Association gave Swedish results with sintered materials. This report indicates that most Swedish blast furnaces which use coke are using 100 per cent sinter. Many of these use a self-fluxing sinter. Their results show that coke consumption can be reduced up to 25 per cent and with self-fluxing sinter there is a further savings of 10 to 15 per cent. There is also an increase in production of up to 100 per cent. They have found, however, that the use of sinter results in an increased tendency for the charge to hang. These results are particularly interesting inasmuch as sintering has been used in Sweden since 1915, and as early as 1935 the average proportion of sinter in the ore burden was 80 per cent for all blast furnaces.

Reflecting the attention given burden preparation, statistics of the American Iron & Steel Institute show a definite drop over the past ten years in the amount of raw materials used to make a ton of pig iron. In 1957, for the first time, less than three tons of coke, limestone and iron-bearing materials were consumed in the blast

furnace for each ton of iron obtained.

The increasing use of beneficiated ore and sinter burden in the blast furnaces will probably require higher hot blast temperatures to obtain maximum benefits. Some blast furnace stoves now deliver straight line hot blast temperatures up to 1600 F, but in the future stoves may have to deliver blast as hot as 1900 F. With limitations in present height of checkers and the temperature of the dome brick, there are some questions as to whether increased heat may be obtained from existing stoves.

U. S. Steel started a research program to evaluate these factors. The results of the survey so far indicate the gas distribution and temperature distribution at any cross section in the blast furnace stove is nearly uniform. The heat transfer mechanism in the different zones of the stove indicates it may be desirable to use checker brick of higher thermal conductivity in the upper part of the stove, and to decrease the air film resistance in the low part of the stove by increasing the gas velocity. Calculations indicate that a fully automatic reversing stove operating on one hour cooling and two hours heating can probably maintain a blast temperature of 1800 F.

Some of the visitors to the Soviet Union report that the Zaporozhstal plant plans to rebuild its blast furnace stoves for 1800 F blast temperature. They also plan to use natural gas injection through the tuyeres, hoping to get a saving of five per cent in coke with no increase in iron. Some 2100 to 2500 cu ft per ton of natural gas will be used and this will not be preheated. This practice is an attempt to substitute gaseous fuel for expensive high-sulphur coke.

At Kuztnesk a blast furnace was observed operating with hearth cooling installed in 1956. The hearth cooling is accomplished by circulating air in the foundation under the brick hearth. The air is furnished by two 10,000-cfm, 3-in. pressure fans which feed through square ducts into four groups of pipes. These pipes (18 of 8 in. diam, 18 of 5 in. diam) conduct the ventilating air through the furnace foundation. In going through the foundation, the air temperature rises about 12 to 14 F. The Russians claim this method of cooling maintains the bottom for a much longer period and prevents cracking. Their objective is to obtain indefinite bottom life.

This operating experience confirms test results of the research program made on blast furnace hearth sponsored by the AISE at Columbia University several years ago.

The Soviet Steel Combine is testing a computer as a means to help control blast furnaces. The Russians believe it can boost pig iron output and save coke. The test program is carried out on a blast furnace at the Azov plant which is near Rostov. Computers use data and formulae established by the furnace operation. These formulae involve 39 variables, some of which change quite rapidly. Once programmed, the computers can analyze all variations from optimum and feed back the required instructions needed to bring the furnace back to optimum smelting. Control units being tested include devices to measure the iron level, hearth temperature, iron temperature and slag temperatures.

A similar data analysis was carried out by an American Steel company several years ago, but it is not believed that these results are yet being used for furnace control.

Some rather interesting data on ironmaking may come as a result of work by U. S. Steel scientists. They conducted experiments in which the contents of an experimental blast furnace were frozen by a blast of cold nitrogen during the ironmaking process. This gave the scientists an opportunity to examine the full cycle of the transformation of raw materials into iron as it takes place inside the blast furnace. Preliminary observations indicated that the raw materials which are loaded into the top of the furnace in layers move down to the combustion zone in stratified form. Until they reach the smelting zone they remain relatively unchanged in physical appearance.

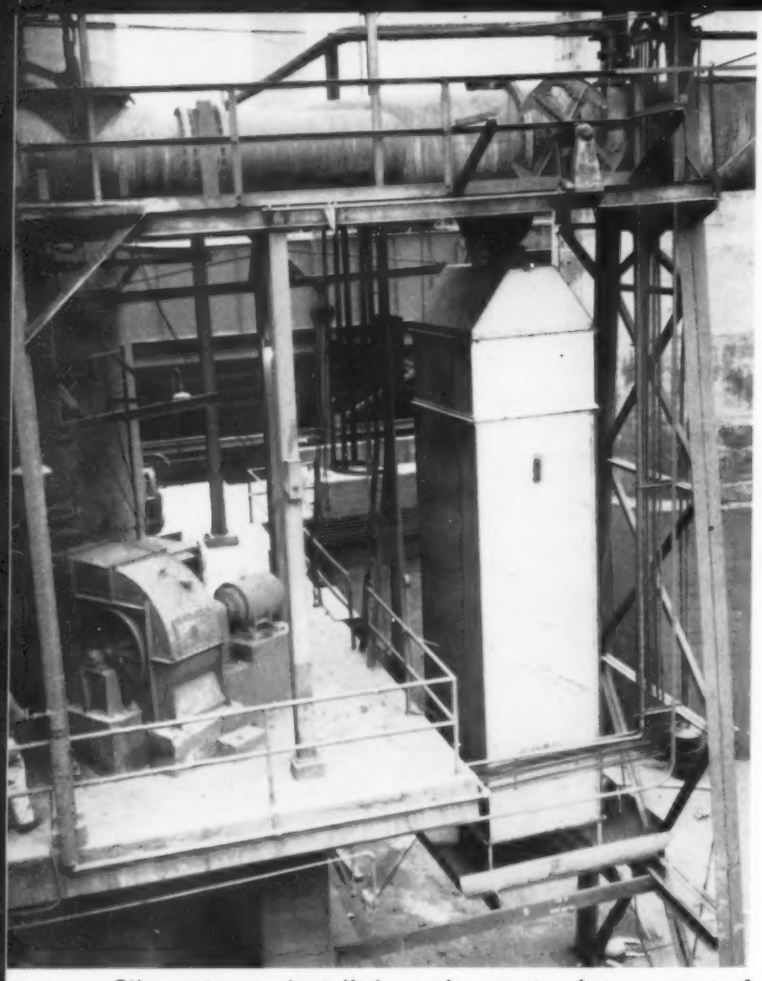
In the United States, a new method for controlling the operation of a blast furnace may enable blast volume and temperature to be maintained at higher values, close to the critical, without risking hanging. This invention is based on the discovery that a rapid rate of pressure increase usually foretells furnace conditions which cause hanging. The new control uses an instrument which shows the rate of pressure change in the hot blast line and which is preferably connected to an automatic control device to cut back blast temperature and volume in response to excessive rates of pressure increase.

It is reported that Bethlehem Steel Corp. has developed a new blast furnace tuyere design which reduces tuyere cost 77 per cent. Efficient cooling is obtained through a 98 per cent conductivity copper nose and a 90 per cent conductivity body compared with pure copper. These tuyeres give five times the life of conventional tuyeres. The nose, which burns out first, is replaceable without scrapping the body. The unit is known as the Eberhardt tuyere.

Noise control devices were placed on the snort valves of one blast furnace at Kaiser Steel Corp. as a test project this year. The device is about 24 ft long x 6 ft wide and is basically a sound absorber column filled with spun metallic wool held in place by a face sheet of glass fiber which in turn is covered by a perforated galvanized sheet face plate. The entire assembly is suspended from the outlet flange of the snort valve and can be used at temperatures over 500 F. It is reported that the silencer reduced the noise from the snort valve to acceptable levels. Since the test work was carried out, Kaiser has installed two additional silencers on other blast furnaces.

An interesting method of checking the condition of the lining of the blast furnace is the use of remote photography. Colorado Fuel & Iron photographers developed a technique of photographing the stock line armor inside of their furnaces. This was done by mounting a camera in a special box and lowering it into the furnace. Observation of the resultant pictures gave the operators vital information.

In Europe horizontal flow plate type precipitators are commonly used for cleaning blast furnace gas. An improved precipitator of this type was recently developed based on rather extensive model tests. This new design features an improved new flushing arrangement for cleaning the interior parts of the precipitator. This precipitator can be designed for high collecting efficiencies and for high inlet dust concentrations.



Silencers were installed on the snort valve on some of Kaiser's blast furnaces.

It has been estimated that blast furnace capacity, which at the beginning of 1958 totaled 91,000,110 net tons, will have to be increased to 120,000,000 net tons by 1970. If this additional capacity were to come from new blast furnaces, it would take about 50 new units. Since a new blast furnace and auxiliaries cost close to $40,000,000 the pressure is on to find other methods for reducing iron ore and to improve the blast furnace process itself.

Needless to say, intensive experimentation on direct reduction processes has proceeded all year. One new process described during the year is known as the Stelling process, developed in Sweden. It goes one step beyond direct reduction because, in addition to reducing the ore, it diffuses carbon into the iron to produce steel directly. It operates in a fluidized ore bed at temperatures around 1100 F, at atmospheric pressures with a reducing gas, carbon monoxide, that requires neither heating nor cooling. A pilot plant has been operating for some time and a Swedish company has taken over licensing and sales rights.

In the key steps of the process, the ore is first preheated and oxidized; in the second step, the ore is prereduced, and in the final step, reduction is continued to produce cementite instead of metallic iron.

A new process which has stirred up a great deal of interest was discussed at the annual convention of the AISE. This is the Strategic-Udy direct reduction process, which process uses electric arc smelting of iron. The smelting technique, however, uses a direct-fired rotary kiln for partial prereduction of the iron ore before it is charged into the electric furnace. This reduces power consumption to a point where the electric furnace can compete in some locations.

Previous electric furnace processes were economical only if the power cost was below six mills per kwhr and coking coal costs were above $50 a ton. They were also economical only in relatively small plant capacities and with high scrap costs.

A 1000-kva electric furnace has been operating in a pilot plant at Niagara Falls for some time. Much of the heat needed for prereducing and preheating the ore in the kiln is supplied by burning the carbon monoxide produced from the reduction reactions in the arc furnace. A mixture of iron ore, flux and coal is continuously fed to the rotary kiln. The ore is heated and prereduced. The flux, which is limestone or dolomite, is calcined and combined with the ore. Maximum temperature of the free-flowing discharge from the kiln is controlled between 1800 and 2300 F. Sufficient coal is fed to the kiln to accomplish the reduction. The coal not used for the prereduction is coked in the kiln and passes out with the other material for use as a preheated reductant in the electric smelting step.

The material from the kiln is charged directly to the electric furnace through insulated feed control bins and controlled feeders.

The process uses an open bath technique. Electrodes are set from ½ in. above the molten slag to 3 in. submerged in the slag, depending on the particular operation. The charged material enters the periphery of the furnace and forms its own angle of repose. The molten bath in the furnace provides a constant electric resistance, and permits high and uniform power inputs. The reaction between the coal and the iron oxides in the molten bath is very rapid. Carbon monoxide gas is quickly liberated and is collected and burnt in the kiln to supply a major portion of the heat of the kiln.

The carbon content may be varied from pig iron at 3½ per cent carbon to a semi-steel at 0.2 per cent carbon with comparative ease. Control of slag composition permits selective smelting to remove contaminating elements such as titanium, manganese, phosphorous, chromium and nickel. These elements can also be recovered for credit if they are present in sufficient concentration. There is also high recovery of iron in the process. A prototype plant at Niagara Falls, Ont. is equipped with three 1000-kva, 3-phase electric smelting furnaces, a large gas or oil-fired rotary kiln with dust collector and fan, and crushing, drying, conveying and bin equipment. It is believed that because of the flexibility and the low capital cost per ton of iron, the process can be adapted to cold metal shops where molten iron would be an advantage. The process can be developed on a unit basis to the production of 50 tons of iron per day and upward and also permits the use of scrap.

The pilot plant uses 1500 to 1800 kwhr per ton and it is estimated that this can be lowered to 1200 kwhr per ton in a large scale unit. Manufacturing costs per ton of pig iron are around $43 a ton.

Another direct reduction process for iron ore produces a sponge iron that can also be charged into the electric steelmaking furnace. This is a process developed by Hojalata y Lamina S.A., at Monterrey, Mexico, where a 200-ton per day plant is being operated by Fierro Esponja S.A. A hematite ore is reduced in fixed bed, batch type reactors by direct gaseous reduction. The

ore used has 66.6 per cent iron, phosphorous of 0.008 and sulphur of 0.020 per cent. The sponge iron produced is charged in electric furnaces in place of pig iron or scrap. It is reported that the steel is of highest quality. The reactor-produced sponge iron has as a typical analysis of 86 per cent metallic iron (90 per cent total iron) with carbon of 0.62 to 2.0 per cent and sulfur of 0.07 per cent.

The reducing atmosphere used in the reactor is about 85 per cent hydrogen and carbon monoxide. The remainder is carbon dioxide, methane and water vapor. This atmosphere is obtained from the natural gas which is locally available.

At this plant five reactors are in use. The reaction cycle takes about four hours plus about 30 minutes for dumping and charging. The reactors are normally so scheduled that each one is at a different state in the cycle, enabling one labor crew to operate the plant. A second unit is to be built with a 500-ton per day capacity. Estimates on capital investment are $33 per annual ton of iron. Estimates for operating cost in a 1000-ton per day plant in the Gulf Coast area are about $34.43 a ton.

It is reported that Inland Steel Co. is experimenting with the smelting of iron ore by a new process. The new technique has been developed in the company's research laboratory but details on the process have not been revealed.

Another interesting development may come from experiments which are going on in a reactor with pig iron, with the objective of making the unit into a steelmaking furnace. The approach consists of using a pig iron charge in a slag that desulphurizes and desiliconizes equally well, relying on turbulent action to bring down the carbon to the mild steel level.

Experimental work is also under way on a hot metal pretreating tower. This, in essence, is a high reactor which will permit hot metal to contact gaseous oxygen. The method oxidizes and substantially removes all of the silicon and a significant amount of carbon from the pig iron. One of the advantages of this equipment is that problems of splashing, refractory erosion and fume production are relatively limited. A perforated plate at the top of the tower is used for the drops. These plates are coated with a heavy layer of special cement so stand up for a number of runs.

Extensive research has been carried out by United States Steel Corp. to evaluate the economies of desulphurization of hot metals. Among some of the conclusions are that the technique used was feasible and could be applied to routine production of blast furnace hot metal. During the trials, hot metal sulphur content was reduced from 0.053 to 0.033 per cent by using 5.6 lb of calcium carbide per ton of hot metal treated. Removal of sulphur by this method instead of in the blast furnace results in 2.9 to 5.5 per cent more iron from the blast furnace and about 3.75 per cent reduction in coke consumption.

Material cost of desulphurization runs from 35 to 40 cents per ton of hot metal exclusive of labor, maintenance, facilities and amortization cost. Net savings in the standard cost per ton of hot metal range from 0.3 to 1.5 per cent. The desulphurized hot metal, when used in the open hearth, is apparently equivalent to normal hot metal of the same sulphur content.

In the coke plant area, improved coal preparation techniques are, in essence, increasing the reserves of metallurgical coal. Many coals once not considered first class coking types can be prepared to give first-class coke. Steps in this direction include multiple mixing bins in order to get good blending, development of sulphur recovery equipment which reduces net operational costs, addition of inerts, and improvements in the design of pulverization equipment and storage bins in order to avoid segregation. Finally development of practical tests for coking coals has been important.

An eastern plant is producing a ferro-coke by treating flue dust to give a carbonized blend of coal and blast furnace flue dust. This is essentially a method of sintering using a conventional coke oven. This plant has made full-scale oven trials in which a blend of 80 per cent high volatile coal and 20 per cent flue dust has been found to yield a coke of satisfactory properties. The coal is screened through a $\frac{3}{4}$-in. screen to remove tramp materials. The content of the flue dust can be varied from 10 to 30 per cent without materially affecting the properties of the coke. Coking time in the 18$\frac{3}{4}$-in. ovens runs between 21 and 23.5 hr. Operation has not shown any indication of damage to the brick work.

It is reported also that the physical properties of the ferro-coke are excellent and have good shatter and tumbler test results. When charged into the blast furnace, it is necessary to make full allowance for the iron in the coke. This coke has been used in a ratio of two parts ferro-coke with three parts of regular coke. A saving of 41 lb of coke per gross ton of iron is indicated when operating with equal parts of ferro and regular coke. An increase of two per cent in iron production can be traced to the use of ferro-coke. It is reported also that Republic Steel has done iron-coke experimentation and has produced 50,000 tons of iron-coke containing 35 per cent Fe from highly bituminous coal and taconite concentrate. A Russian coke plant is said to be working along the same line. In the last war, Yawata Iron & Steel Co. also made a similar product.

A unique method for detecting hot spots in coke ovens is in use at Inland Steel Co.'s East Chicago plant. Equipment consists of a radiation pyrometer mounted on the coke guide with the recorder mounted on the oven's door machine. As the detector sights directly on the coke, the chart records the areas that vary greatly from the normal push temperature. Such surface temperatures indicate the location of the hot spots and the nozzle involved. Procedure then calls for cleaning the nozzle and elimination of the hot spot.

Jones & Laughlin Steel Corp. awarded a contract for the construction of 59 coke ovens at the Pittsburgh Works Div. at a cost of about $6,000,000. The new battery is being built on the site of 60 old ovens, and is scheduled for completion in the fall of 1959. It will have a capacity of 1440 tons of coal daily.

A new wrinkle for ammonia recovery from coke oven gas is being introduced in the coke plant at the Jamshedpur plant of Tata Iron & Steel Ltd. Gas from the coke ovens will be treated with waste pickle liquor from galvanizing operations in the sheet mill. Besides ammonium sulphate, other products such as hydrogen sulphide, ferrous hydroxides and cyanide sludge will be obtained. All of these have important industrial applications.

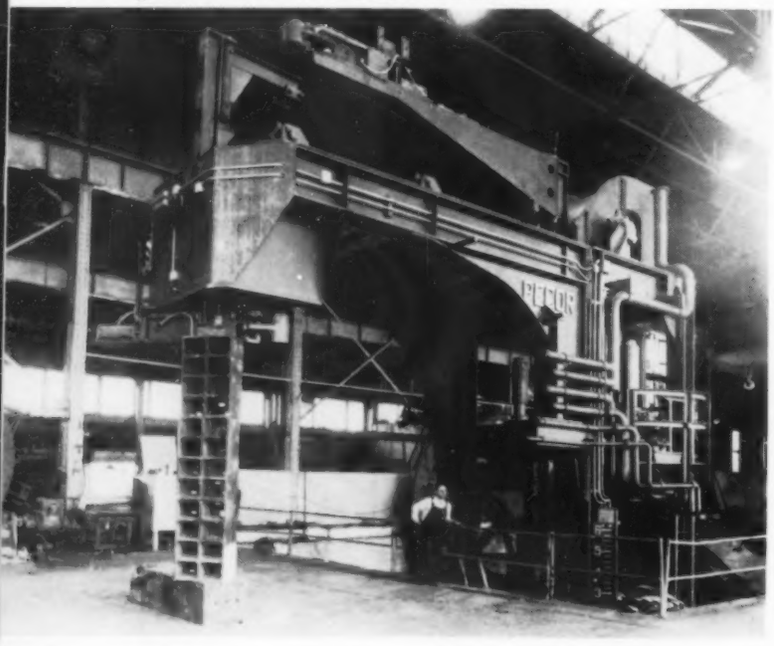
In the past few years the pressure of management has not been toward creating new steelmaking facilities, but rather toward how to gain additional ingot capacity from existing facilities. Engineers and operators have been exploring all possibilities to increase production rates, eliminate bottlenecks and increase efficiency. This has been an important factor in the adoption of oxygen to speed up almost every steelmaking operation.

As a result of this, there is practically no steel plant in the United States which is not in some ways developing a dependable source of oxygen. This is later expanded in the Mechanical Section.

This trend to oxygen usage is in evidence throughout the world. The use of oxygen-blown converters is increasing and in Europe oxygen-blown Thomas converters are in use. In this application, the use of oxygen-enriched blast reduces nitrogen content of the steel and allows a substantial increase in the scrap melting capacity. An air-blown Thomas converter can use only 4 per cent scrap and requires 96 per cent pig iron. However, with a blast enriched to 32 per cent oxygen, as much as 16 per cent scrap may be used. In addition, the blowing time is shortened. In Europe at the present time, about 18,000,000 tons annually or about half of the Thomas steel produced in Western Europe is being blown with an oxygen-enriched blast. In Western Germany all the 11 Thomas steel plants use oxygen-enriched blast. Increasing oxygen content above 32 per cent has an adverse effect on converter bottom life.

In the United States much work was done on injection of oxygen through the roof of the open hearth. Many plants are experimenting with this. Reports show rather conflicting results. In some cases production increases up to 50 per cent were claimed. Some of this may have been an increase over relatively poor performance, but nevertheless there were definite increases in production. Reports on effects on refractories were also varied. Where care was exercised to avoid splashing, the effect on refractories was apparently not too marked. In other shops, the effect was serious.

Special post crane helps operate new 80-ton capacity oxygen steel converters at McLouth Steel.



An extensive series of tests by one company gave a 10 per cent increase in steel production but at a $10 a ton premium over normal procedure. These tests were made on furnaces with silicon roofs. This premium discouraged the practice as long as production demand was within shop capacity. On the other hand, with basic roofs, they are able to operate at sufficiently higher temperatures to make the operation pay.

One of the features which enables better application of oxygen roof jets in open hearths is the use of multi-orifice jets which minimize splash and also thus reduce roof damage to practical levels. On the average, the roof jet installations consume approximately 425 cu ft of oxygen per ton of steel produced.

In the latter part of the year a report indicates that some 70 basic open hearth roofs are now in service or on order. This compares with less than 20 all-basic open hearths at the start of the year. This spurt is due to a recently developed suspended sprung arch design for basic roofs.

Some of the push toward basic brick has come as a result of reports on the operation of a basic furnace at Fairless Works. The campaign life went from about 200 to 350 with basic brick. A feature that makes the design practical is that roof weight is carried partially by the arch and partially by a suspension system. The roof has a series of upright steel plates inserted across the furnace between every third row of steel-jacketed brick. These plates extend from one ft above the roof down to the hot face. When the furnace is heated, the plates and brick weld together to form a rigid structure. Bars through holes in the exposed part of the plates are tied by means of rods to the furnace superstructure, thus suspending the entire roof. Steel beams atop the roof run the length of the furnace and are braced against the superstructure to prevent the roof from heaving upward. The brick contains about 60 per cent magnesite and 40 per cent chrome.

It is reported that the majority of open hearth furnaces in Russia have basic roofs. At Magnitogorsk roof life is some 420 to 450 heats on the 440-ton furnaces, and 650 to 700 heats on the 220 and 275-ton furnaces, usually without patching. On the 440-ton furnaces they take out the slag in the middle of the campaign, replace the ten top courses of checkers and renew end walls, port bridgewalls, front walls and top of back walls. This requires 48 hr. In the smaller furnaces this is done twice in a campaign. In their sixth 5-year plan, basic roofs will be installed on all open hearth units.

Extensive work was sponsored at a British steel plant to determine the possibility of using oxygen in a modified tilting furnace. The results of experiments with bath lancing showed increased production and a considerable reduction in fuel consumption. There was a slight reduction in ingot cost because of gains in fuel, but this is counter-balanced by lower yield and the cost of oxygen. The losses of iron in the slag are higher than with normal practice. Roof life is costly and a serious problem, but the over-all refractory cost per ton appears to be no more than with normal practice.

A British steel producer has been able to improve open hearth operation by changing the design of the ends of open hearth furnaces. This increased furnace

output by 10 to 15 per cent, saved 10 per cent in fuel, and reduced the amount of refractories required. This was done by converting the ends so that they were set square instead of at the customary angle. The new design converts the furnace into a streamlined box with open ends leading into a single uptake the full width of the furnace.

The top-blown oxygen converter process has become quite familiar throughout the world. It is estimated that total annual capacity, either under construction or in operation, amounts to about 17,000,000 tons.

Top-blown oxygen converter capacity in the United States at the end of 1958 was over 4,000,000 tons a year. In 1959 this should increase by another 20 per cent. Companies now with converters in operation or under construction include Acme Steel Co., Jones & Laughlin Steel Corp., Kaiser Steel Corp., and McLouth Steel Corp. In addition to this, several companies have indicated that they plan to install oxygen-converter facilities at a later date. Such announcements emphasize the confidence placed in the process.

In Canada, Algoma Steel Co. and Dominion Foundries & Steel Ltd. are users of the process. In addition to the 16 units represented by the United States and Canadian companies, there are between 30 and 40 converters under construction or in operation in other parts of the world, particularly Germany, Austria, India, Japan and Brazil. One of the chief reasons for this acceptance is the low capital cost, which has been estimated at $15 a ton, compared with about $40 a ton for added open hearth capacity.

During the year operations started at an oxygen converter plant at the Royal Netherlands plant at Ijmuiden Holland. Furnaces at this plant are of 65-ton charge capacity, and most of the heats have been running up to 77 net tons. Average blowing times of 20 to 22 min have been required. This plant is a completely integrated plant with three blast furnaces, four open hearths, and two new oxygen converters.

Jones & Laughlin Steel Corp. announced they are producing 81-ton heats of steel in the oxygen converters at Aliquippa. It is believed this is the largest heat being produced by any basic oxygen furnace in the world. The annual capacity of the furnaces remain at 750,000 tons, since the time factor rises from 39 to 55 min per heat.

Sulphur removal by the oxygen process has been found to be remarkably uniform and consistently better than that experienced in the open hearth and in single-slag electric furnace heats. In general, the process produces steel containing 33 per cent less sulphur than the hot metal charged into the process.

Another feature of the oxygen converter process is the relatively high residual manganese at the end of the heat. When using pig iron with from 0.3 to 2.5 per cent manganese and blowing down to 0.05 per cent carbon, some 20 to 25 per cent of the original manganese remains in the steel. By comparison a low carbon open hearth heat does not usually retain more than 10 per cent of the original manganese of the charge.

It is reported that at the Donawitz plant of the Osterreisch Alpine Montangesellschaft (where the process originated) techniques have been developed for using the top blown oxygen converter for high carbon steel production.The technique is to catch the carbon on the way down. Since there is no measuring device which will tell the steelmaker the progress of the refining reactions in the converter, it is necessary to take the time of blowing as the principal guide. With a given hot metal composition, blowing time will give a good working basis for the catch-carbon technique if oxygen input is closely controlled.

Equipment is available to automatically make additions to the ladle during the steel pouring operation.

The new oxygen converter process which the Centre National de Recherches Metallurgiques has been experimenting with in Belgium combines top and bottom blowing of a converter. Some of the conclusions from tests are as follows: metallic yield runs up to 90 per cent. There can be high consumption of scrap up to 500 lb per net ton of steel. There is low consumption of oxygen, 1900 to 2050 cu ft per ton. Lime consumption runs 186 lb per ton of steel. Refining speed is high—some 35 to 45 sec per ton of steel in the 26-ton converter. It is easy to produce steel with both sulphur and phosphorous below 0.02 per cent. The nitrogen content of the steel depends on the purity of the oxygen and with 99.5 per cent oxygen the nitrogen drops below 0.003 per cent.

The high temperatures obtained in the top-blown oxygen converter process may in some cases be sufficient to volatilize iron, which then appears as the dense brown fumes which cause a dirt-removal problem in the exhaust gases. The use of a tilted rotating vessel, as in the Kaldo process, has possibilities for eliminating some of the dust problem. It differs from the ordinary top blown converter in that the oxygen is introduced in the atmosphere above the bath, rather than directly into the metal.

The vessel employed in the Kaldo process is quite similar to the familiar bessemer converter but in addition to being tilted back and forth on trunions for charging and discharging, it can also be rotated rapidly on its longitudinal axis at speeds up to 30 rpm. The oxygen consumption for the process is somewhat higher than the top-blown oxygen process, but oxygen of lower purity can apparently be used. An American company recently took over the process which should soon result in extensive development and promotion of the process in the United States.

It is reported that the Russians are developing a method of operating a continuous converter for steelmaking. The converter is in the form of a 75-ft long spout which is nothing more or less than a large number of small converters placed in line and top-blown with oxygen. The hot metal enters the receiver of the spout and is blown as it moves along the spout. It is reported that the method can be used to obtain low carbon semi-steel for open hearth charge or to produce finished steel.

A variation in the oxygen lance for use in oxygen converters uses a slag-displacing medium which can be steam, carbon dioxide or an inert gas. This is forced through an outer channel of the lance with enough pressure to displace the slag and expose the bath surface immediately below the lance for impingement by the oxygen jet which goes through the central pipe. An advantage of the device is that it permits lower oxygen velocities thereby avoiding local over-concentration of oxygen and excessive local heating.

The Acme Steel Co. plant at Riverdale, Ill., the first major cupola and top-blown oxygen converter installation in this country, is to go into operation early in 1959 with a capacity of 450,000 tons per year. The cupolas will have an inside diameter of 156 in. at the base plate and 114 in. at the hearth. They will handle a 40-ft column of raw material and will be water-cooled in the melting zone and stack. Automatic weighing and vibrating feeders will be used to make the charging semi-automatic. A split-wind blowing system is being installed to enable operation of both cupolas simultaneously. The blast will be heated to 1200 F by a recuperator fired by waste gas. The converters are expected to tap about 50 tons per heat.

An interesting study of electric furnace operation, made by means of photography at Republic Steel Corp., was aimed particularly at the operation of the arc. These studies indicated that hot-spots were located where the electric arc operating adjacent to them showed a much higher average power level than the arcs in areas where no hot spots existed. When the difference in arc power level was corrected by adjustment of the electrode regulator control circuits, hot spots were eliminated.

After completing the adjustments, the following results were reported: (1) a 12 per cent reduction in refractory material for side wall lining; (2) a 9 per cent reduction in refractory material for roof or dome replacement; (3) hot spot severity decreased to a point where no shutdowns were required between relines.

In most cases such adjustments require only the installation of three accurately calibrated meters for measuring the average arc power levels. Exact balancing procedure may vary from furnace to furnace.

The electric furnace shop at U. S. Steel's Duquesne Works was expanded to provide room for a new 83-ton electric furnace. This is the fifth furnace in the shop and increases annual capacity by 75,000 tons to a new total of 294,000 tons per year.

Vacuum melting made great strides during the year. Ingot sizes by the vacuum induction process have increased from a maximum of about 3000 lb a year ago to 5000 lb today. A year ago the maximum sized ingot which could be made by the vacuum arc process was 12,000 lb; soon 40,000 lb ingots will be available. At the end of the year, maximum available induction melting capacity was probably around 14,000 tons and consumable electrode capacity was probably about 50,000 tons.

The Steel and Tube Div. of the Timken Roller Bearing Co. installed its first consumable electrode vacuum arc furnace during the year at a cost of $500,000. This unit will produce about 200 tons of high quality alloy steel a month. The consumable electrodes for the new vacuum arc unit are forged from ingots which are made in Timken's arc furnaces.

Vacuum pouring is rapidly becoming a routine process. Companies using vacuum pouring quite extensively are U. S. Steel, Bethlehem and the Midvale-Heppenstall Co. Important papers on this technique were given at meetings of the AISE by E. A. Reid and Henry C. Bigge, both of Bethlehem Steel. Bethehem's setup uses multi-stage steam jets to evacuate the pouring chamber containing the ingot mold. Two 250-ton units are in use and pouring is alternated between the two tanks, since they use the same pumping system. Vacuum pouring definitely reduces hydrogen content of steel which results in flake-free forgings.

U. S. Steel has reported that steel deoxidized with aluminum or other strong deoxidizers do not lend themselves readily to vacuum deoxidation because the deoxidizers form stable compounds with oxygen. Chemical analysis at various locations in ingots do not show any undue alloy segregation resulting from vacuum casting.

Standard Steel Works, a division of Baldwin-Lima-Hamilton Corp., has placed a contract for the design and construction of a new vacuum stream degassing system. The system will have two vacuum chambers, each capable of receiving a 15-ton pour into an ingot mold. The new facilities also include a new 15-ton electric furnace. The project is a part of a $12,000,000 expansion and improvement program currently under way.

Reports from Germany describe two vacuum degassing methods based on the circulation of molten steel from the ladle through an evacuated chamber, from where it flows back into the ladle. Both methods are said to be in satisfactory commercial operation.

An automatic pouring control designed by Republic Steel Corp. gives uniform ingot weights, which results in increased yield since cropping can be kept to a minimum. It is reported that the method keeps ingot weights to within one per cent of that desired. The control has three elements: a weighing device to sense the quantity of metal poured, a hydraulic unit to replace the manual lever of the ladle stopper, and a control unit to operate the stopper when the correct weight has been poured.

An improved design of feeder for making additions to the ladle was announced during 1958. The original feeder introduced some years ago consisted of a suitable hopper, an electrical vibrating feeder, an adjustable chute and a control panel. The new design uses one or more hoppers, with each having a separate vibrating feeder. Each bin is mounted on load cells of the strain gage type. It is not necessary to weight the alloys going into the hoppers. The operator can set the control panel to deliver specific amounts of one or more materials to be added to the ladle. The rate at which the additions are made can also be controlled. When the required amount has been added, the equipment stops,

regardless of the amount of alloys remaining in the hopper.

A new ingot mold coating used by Armco Steel Corp. is said to help prevent hot metal from sticking to the walls of the mold, thus reducing scabs, blister, surface lamination and slivers. What happens is that as the splatterings hit the side of the mold, the coating swells and forms an insulating layer. This prevents the metal from freezing on the mold. Use of this coating is said to have resulted in substantial reduction in rejections of cold rolled sheet. The coating costs less than 12¢ per ton of product, including application.

The rising cost of refractories has made steel companies take a very close look at this item. One result has been much more uniform quality in the refractories which are being received.

In an effort to improve open hearth life and performance, one steel company has tried a carbon subhearth. This company has experimented with one unit and is now installing a second. The first unit gave a 60 per cent reduction in bottom delays, higher bottom temperatures, faster temperature recovery after repairs and labor savings in installation.

Tar as a bond in basic refractories is finding favor. At room temperatures tar-bonded brick are strong and tough, and may be handled with little chance of breakage. Strength decreases as temperature rises to the point at which the tar softens. At 1500 F under reducing conditions, the tar decomposes and cokes, forming a carbon bond which increases compressive strength. At higher temperatures under oxidizing conditions, the carbon on the hot face of the brick starts to burn away but as the operating temperatures of steelmaking furnaces are approached, ceramic bonds begin to form. At temperatures approaching 3000 F, the brick again becomes strong.

The brick cannot be used where moisture is likely to come in contact with them. There have also been some experiments with tar-bonded refractories in electric furnaces and open hearth furnaces. The refractories have good spall-resistance, resist fluxing action of highly basic slags and those containing relatively large amounts of silica.

By learning how to make pure silica boil and foam, a glass company created an entirely new acid-resistant insulating and refractory material. The material is 99 per cent pure fused silica. It cannot be oxidized and it will not absorb moisture. It is unaffected by all acids with the exception of hydrofluoric and hot phosphoric. The material offers continuous insulating protection and withstands thermal shock within the range of −450 to 2200 F. A 1-in. layer is equivalent to 18 in. of brick at a temperature of 250 F. A very low expansion coefficient of 3.5×10^{-7}, about $\frac{1}{18}$ that of low carbon steel, gives the material volume stability throughout its entire temperature operating range. For operating temperatures up to 2200 F, the material actually expands whereas most insulations shrink. It is light in weight (10 to 12 lb per cu ft).

The use of so-called contractor's construction equipment for many steel plant maintenance operations continues to grow. As an example, Jones & Laughlin at their Aliquippa plant are using a common piece of grading equipment which consists of a triangular telescoping boom which carries the working attachments at the end. This boom can be swung in a complete circle, raised and lowered or tilted from each side of the center. Such equipment has been very effective in cleaning out slag pits, skulling out the new oxygen converters, and even unloading cars of wire coils. The same equipment is also used at several ferromanganese plants in the Pittsburgh district to remove ferromanganese which has been cast in the special gondola cars used for this purpose.

Continued attempts are under way to clean up smoke from the various steelmaking processes. U. S. Steel Corp. will experiment with a wet gas scrubber at Edgar Thomson Works. This unit will cool gases to 160 F, pass them through a water film. Effluent will be pumped to a thickener.

A new precipitator electrode uses a controlled corona discharge. By this means, substantially greater power may be applied and higher efficiencies obtained with existing equipment, permitting operation well beyond originally designed capacity. In new installations for a given rating, the new electrodes permit precipitators of smaller physical dimensions.

Work is constantly going on in the Soviet Union on continuous casting. In 1956 there were eight experimental pilot and industrial plants in operation. They formed relatively large steel sections, with billets up to $10\frac{1}{2}$ in. square and slabs running up to $6\frac{3}{4} \times 17\frac{1}{2}$ in. and $5\frac{3}{4} \times 23\frac{1}{2}$ in.

It is reported that a new 8-strand continuous casting plant was installed about a year ago for an Italian steel plant by a German company. With all eight strands in operation, the unit has a capacity of 60 to 70 tons per hr. Water-cooled copper molds are used, with a reciprocating movement of one in. The larger molds are $5\frac{1}{2}$ in. square.

ROLLING

Automatic controls for rolling mills are definitely on the upswing and punch cards seem to be leading the way. Such systems are either completed or under way on the following mills: Allegheny Ludlum Steel Corp.'s reversing rougher at Brackenridge; Jones & Laughlin's two reversing roughers at Aliquippa and Cleveland; Inland Steel's universal slabbing mill; U. S. Steel's structural and blooming mills at South Works, universal slabbing mill at Gary, two blooming mills at Duquesne, and a pilot mill at Monroeville; and Empire Steel's reversing rougher at Mansfield.

In addition, they are being supplied to an Eastern reversing plate mill and to a number of foreign mills.

As mentioned Jones & Laughlin Steel Corp. has two reversing roughers programmed by means of punched cards. The unit at Cleveland is quite similar to the Aliquippa mill, but with a difference in the card reading, for in the Cleveland installation, the card reader reads out only one pass at a time, so that no storage element is required. This digital information is fed through a code converter and a selsyn-simulating transformer into the comparator where the program setting is subtracted from the roll-separation signal. The resultant is amplified and used to reset the screws to the programmed setting.

Another difference is that the strain gage which was used originally at Aliquippa on the mill housing to indi-

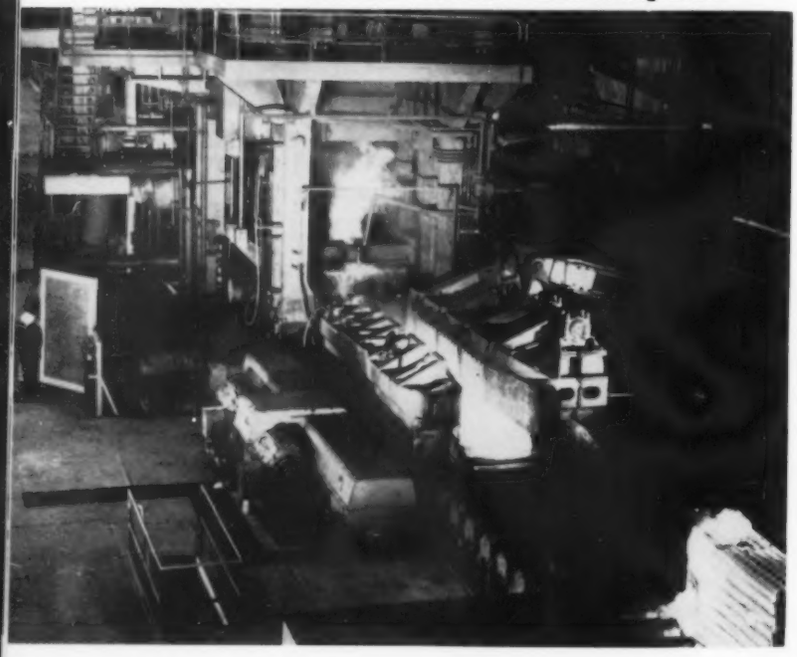
Kaiser Steel completely rebuilt its 86-in. hot strip mill.

cate when steel was out of the mill has been replaced by strip radiation detectors focused on the steel in both mills.

Aliquippa is getting about 2100 tons a turn through its reversing rougher, and expects eventually to get about the same tonnage as from a continuous roughing train. Roughing cycles average about 58 sec.

Toward the end of 1958 a completely automatic card programmed slabbing mill was started. This mill has a

Kaiser also installed a new universal slabbing mill.



12,000-hp mill drive and a 4000-hp edger drive. It is capable of rolling ingots either singly or in tandem into slabs in accordance with the rolling schedule stored on punched cards. Automatic functions are mill roll position, edger roll position, right and left manipulator position, mill speed control, table speed control, manipulation of edge to flat, flat to edge or 180-degree turn, tandem rolling, starting and stopping the mill, and mill and edger draft compensation. The complete information necessary to roll a schedule is contained on a single punched card with provisions for a maximum of 23 passes. The card reader provides commands to the control equipment direct from the card, eliminating intermediate storage.

A static switching system interprets data from the card and provides the necessary sequencing of operations to roll the ingots into the slabs. Hot metal detectors and limit switches provide signals indicating the location of the metal and completion of a function to guide the sequence control through its cycle.

An important requisite for the success of card programming is a person or persons who can visualize the mill operation before the fact and convert all the factors of rolling to dimensions and time sequence for punching into the cards. This person must have greater skills and vision than the present rollers to prepare and build up a library of punch cards to meet the product range.

The grand-daddy of all strip rolling mills, which initiated wide strip production in the steel industry, retired in 1958. This was the Butler hot strip mill which went into operation back in 1926 and which at that time cost about $2,000,000. The mill was replaced by a new unit about the mid-year at an estimated cost of $26,000,000. It can roll 52-in. wide material and deliver strip to the coiler at speeds up to 2000 fpm.

The mill is driven by a total of 33,000 connected hp from seven motors. It is heavily powered, with 589 hp for each inch of width. To heat product for the mill, three new 80-ft long slab heating furnaces were installed. Coils will weigh up to 17,000 lb.

Kaiser Steel Corp. put into operations its revamped 86-in. hot strip mill. The mill now has three recuperative slab reheating furnaces, a 39½ in. x 80-in. two-high scalebreaker, a four-high, 136-in. reversing broadside mill and a slab squeezer, followed by four 89-in., 4-high roughing stands. The mill is designed to handle slabs ranging from 2000 to 37,700 lb with a thickness of 4 to 7 in., 18 to 72 in. wide and from 100 to 264 in. long. The new roughing stands were integrated with the plant's existing 6-stand, 86-in. finishing mill which was relocated in a new building.

Youngstown Sheet and Tube Co. announced that it will revamp its 79-in. hot strip mill at the Campbell Works at a cost of over $50,000,000. Improvements will enable the mill to roll larger diameter coils up to 40,000 lb. The program consists of the following: five new buildings with 210,000 sq ft of floor space, three new slab heating furnaces, a new roughing section and a new crop shear. New power units will be installed on the present finishing section. As part of the program, temper mills and pickling lines are being altered for the larger diameter coils, and new shearing capacity is being installed.

The project is pointed toward the use of larger slabs—up to 9½ in. thick. The roughing section will have a 6-

stand roughing train compared with the present 4-stand train. The new mills will consist of a vertical edging mill, a scalebreaker, a 42 x 54 x 136-in. broadside mill and two 42 x 54 x 79-in. universal roughing mills. Three existing universal roughing mills will be used. Some 33,000 hp will be used on the roughing mill.

The rolling speed of the present finishing section will be increased from 1400 to 2250 fpm and the latest automatic electronic equipment is to be installed for gage and width control. The finishing section drives will have 33,500 hp.

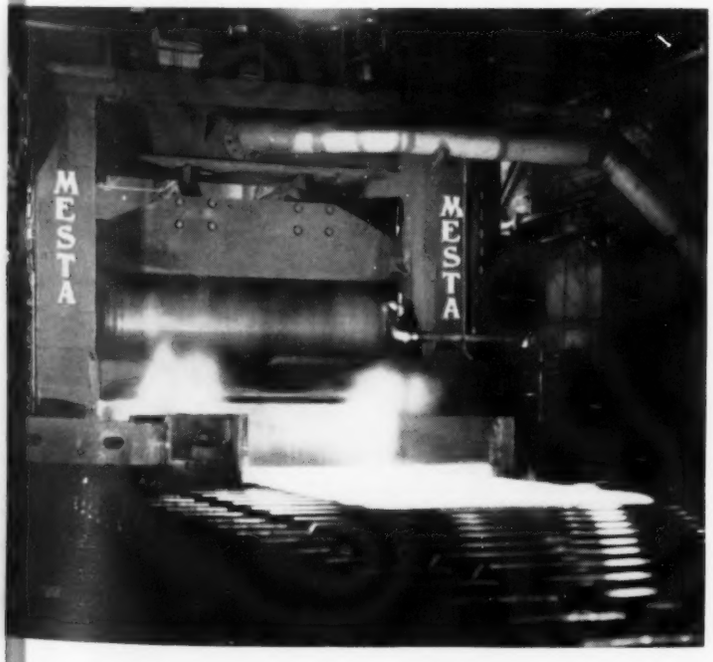
Unusually fast speed featured the revamp of the four-stand tandem mill by Granite City Steel Co. As revamped, the mill now has a top speed of 3600 fpm and the mill can produce some 40 per cent more tonnage.

In the new setup the old 2500-hp No. 2 stand motor will drive No. 1 stand, whose original 1500-hp motor was removed from service. The old No. 3 stand motor (relocated) is used as half of a double armature drive for No. 2 stand. The same procedure was used for No. 3 stand, using the old No. 4 stand motor as half of the double armature drive for No. 3 stand. No. 4 stand is powered by new triple-armature 5000-hp motor. A new 1200-hp, double armature motor was used on the delivery reel. Total drive horsepower is now 18,700. Rated mill capacity is 750,000 tons per year.

A new unit for measuring lineal length of ferrous strip material passing a given point has been developed. The unit was developed primarily for use with electrolytic tinning lines but can be used in any cold strip application. The system will record the exact distance in an 8 to 1 range of operating speeds with a degree of accuracy of better than 0.1 per cent in its dynamic range. A unique electronic servosystem is used to compensate for variation in magnetic distances between pulses due to inherent delay in the electrical system and variations in running speeds.

There is no physical contact between the measuring system and the material being evaluated. The system operates on the principle of magnetic recording. The unit is calibrated to operate in the range of 300 to 2400 fpm and higher ranges are available.

This 148-in., 4-high reversing plate mill is the widest in the Far West.



New Stelco bloomer can roll ingots weighing up to 30 tons.

A new control device has been developed for automatically measuring the length of steel sheets moving along a conveyor belt at speeds up to 5000 fpm and rejecting short or long sheets. A bank of reader photocells and an interrogator photocell are positioned along a conveyor belt so that the leading edge of the sheet crosses the interrogator position at the same instant as the trailing edge is positioned over the center of the reader bank. Breaking the interrogator light beam energizes the reader bank of photocells. For every cell covered by the steel sheet, a corresponding panel light glows. The photocells in the reader bank are spaced on $\frac{1}{32}$-in. centers so each pilot lamp on the control panel represents $\frac{1}{32}$-in. increment of length. The accuracy of the system is equal to plus or minus 0.003 in. and is completely independent of the speed of the conveyor line. When an out-of-tolerance sheet is measured, the control unit produces a signal which actuates an alarm and operates an automatic reject system which takes the sheet off the line.

A width gage developed by the British Iron & Steel Research Association is a servo-driven optical arrangement. It relies on natural radiation of infrared rays from the hot strip and is sufficiently sensitive to respond to material that has cooled to a very dull red. Two edge followers are used, each of which tracks the individual motion of the edges, and the combined readings are summated electrically to give a signal proportional to the deviation in total width. This unit has been installed on the continuous hot strip mill at the Steel Company of Wales.

New Republic bar mill represents investment of more than $18,000,000.

A similar gaging system has been developed in the United States. Approximately 25 gages which use radiation from the strip are in use in the United States.

Shown at the 1958 AISE Iron & Steel Exposition was a new X-ray thickness gage which differs from previous designs in that it had transistors for components instead of vacuum tubes. This design gives higher reliability, simplicity of service and ease of operation. The gage is capable of measuring steel up to 600 mills thick.

The gage features transistor plug-in electronic panels which will reduce servicing downtime. It is designed to give continuous tolerance control of strip to better than one per cent of the thickness being measured.

A continuous draft indicator for rolling mills is particularly adaptable for continuously indicating the amount of reduction in the thickness of strip made by nonreversing mills, with specific application to the mills where small reductions are made.

The unit operates on the principle that the percentage reduction between the entry and the exit sides of the mill is in exact inverse ratio to the percentage elongation between the two points. Contacting rolls are put on both sides of the mill and are in contact with the strip. The surface speeds of these rolls correspond to the linear speed of the strip. The differences between the two speeds is a measure of the elongation which is also in turn a direct measure of the per cent reduction in thickness.

There has been increased interest in a method of gage control sponsored by the British Iron & Steel Research Association. Using a gage on the mill housing to measure rolling pressure, the system is said to offer the advantage of early detection of gage variation. It is claimed that off-gage scrap is lower than with other systems. A system of this type has been installed at the Dominion Foundries & Steel, Ltd. in Hamilton, Canada.

An American company has announced a system for automatically controlling thickness of steel strip and plate which is similar to the BISRA control in principle. This is called the gage meter system. It uses a patented thickness measuring system in which the mill itself is a flying micrometer from which the system calculates metal thickness and automatically adjusts roll opening or interstand tension to provide a uniform finished product. Control can be applied to both new and existing mills. It is now being applied to hot strip mills, reversing cold mills and tandem cold mills, and is said to eliminate the delay inherent in some of the previous systems. In a 6-stand mill, for example, the first gage control is placed on stand No. 2 so that it has an opportunity to correct the tail end as tension is lost between stands No. 1 and 2. Working on tension between stands No. 4 and 5, stand No. 5 control feeds metal of essentially constant thickness into the final stand, thereby enabling the stand to make a constant reduction and feed out a constant shape.

Jones & Laughlin Steel Corp. reports that the gage controls on its 5-stand cold mill as well as a somewhat similar unit on the new 4-stand tandem mill at Cleveland are giving satisfactory operation. The control scheme used on these two mills is not as automatic as some applied on other mills. At Aliquippa, an X-ray gage located after No. 5 stand feeds a signal into a transistor discriminator which produces a positive or negative current signal, depending on the direction of the error. The signal is amplified and fed into the voltage regulators for No. 1, 2 and 3 generators, and these are changed equally to correct for the deviations measured by the X-ray gage. A manual rheostat is provided so the roller can reduce the effectiveness of the signal,

and he also uses a vernier rheostat to adjust tension between stands No. 1 and 2 by slowing down Stand 1 motor.

At the 4-stand mill at Cleveland, the system is slightly modified. Here the first two stands are regulated by the gage control to produce the proper tension between stands No. 2 and 3.

Research has shown that a decrease in friction between the rolls and the strip will lower rolling pressures for a given strip reduction as well as increasing the amount of possible reduction. By improved lubrication, higher speeds of rolling can be obtained.

A tentative conclusion from this research is that the extent of the friction between rolls and strip appears to depend on the thickness of the oil layer present in the roll bite during strip reduction. This friction is reduced and better lubrication afforded as this amount of oil is increased up to certain limits. At low rolling speeds, more oil offers little improvement. At higher speeds the improvement is progressive up to the point where thicker films will not enter the roll bite. Also, with comparable oil films, friction decreases with an increase in rolling speed.

At Louisville, Ohio, all of the facilities of the new $17,000,000 stainless and strip division plant of J & L Steel Corp. are now completed. This is the nation's newest source of stainless steel sheet and strip. The plant has an annual capacity of 36,000 tons of flat-rolled stainless steel. The equipment includes a 52-in. cluster type cold mill. An innovation on this mill is the crown adjustment which makes it possible to maintain extremely accurate gage along the entire width of the coils. This mill is capable of rolling stainless steel sheets in thickness ranging from $\frac{3}{16}$ down to 0.003 in.

In a new process to produce strip from powder, a refined powder is fed between two rolls, where it is hit by a spray of steam. As the powder is compacted between the rolls, a pair of specially designed disks rotate at the edges of the rolls to form the strip edge to the desired width. The material leaving the rolls is called a green compact, too brittle to use. Subsequent roasting and an additional rolling complete the process. So far the work has been done with copper but it is believed that the same process can be used on almost any nonferrous metal.

An interesting rolling mill is the 165-in. 4-high reversing plate mill at Hattingen, Germany. This mill has a twin motor drive which receives power from rectifiers.

A 140-in., four-high plate mill with vertical edgers is being installed at Lukens Steel Co. This mill is arranged to operate as a roughing mill to reduce ingots for subsequent finishing on existing plate mills, or it can complete the rolling of plates to the finished size.

The vertical edging mill, placed in tandem with the four-high mill, will be the largest ever used with a plate mill in this country and provides edge rolling of the ingot which remains in the horizontal position during the complete operation. This mill drive is also powered from mercury arc rectifiers.

Kaiser Steel Corp. started up a new plate mill to roll steel plate up to 126 in. wide and 720 in. long. This unit replaces the former plate mill at this plant which could produce plate up to 96 in. wide and 600 in. long. The new mill is powered by the 7000-hp motor which drove the old 110-in., 3-high mill.

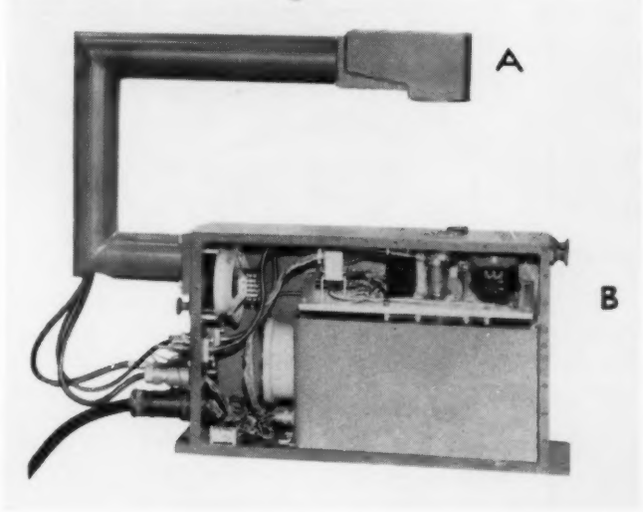
Hot ingot peeling machine was developed originally for alloy and stainless steels.

U. S. Steel Corp. is using a new sandwich rolling process which produces steel sheets up to 90 in. wide. The new method consists of sandwiching stainless or alloy steel plates between two heavier plates of ordinary carbon steel, closing the assembly with welded-in side and end bars, and after heating—rolling the sandwich.

As an example of the kind of work that can be done, stainless plates, $\frac{5}{16}$ in. thick, can be rolled down to a nominal thickness of 0.033 in. each. When the expendable end and side bars are sheared off to open the assembly, the stainless sheets will measure 90 in. wide and 230 in. long. One outstanding advantage is that existing rolling mills can be used. The carbon steel cover plates also have salvage and sales value. The sandwiches have the rolling characteristics of the carbon steel cover plates rather than that of the stainless or alloy steels which are inside. Therefore there is no revamping of the mills or additional power required.

New facilities at South Works of the U. S. Steel consist of a blooming mill, new soaking pits, reheating furnaces, a secondary or breakdown mill, and a cross-country 4-stand structural mill. These units replace two obsolete blooming mills and two obsolete structural mills. It is designed so that the entire mill stands are changed instead of changing rolls.

Ruggedness and ease of maintenance feature new X-ray gage introduced during the year.



Pittsburgh Steel Co. recently completed their new 6-stand billet mill. This is a $6,000,000, 30-in. mill consisting of three horizontal mill stands alternating with three vertical sets of rolls. Six 1750-hp motors are used to drive the six stands. The mill will roll blooms 9 x 10 in. down to 4 in. square, as well as rounds for seamless tubes down to 4⅝ in. in diameter. This mill completes the $111,000,000 Pittsburgh Steel expansion program.

Early in 1958 production began on Lone Star Steel's new stretch-reducing mill. This process permits production of tubing and smaller size casing and line pipe from the company's No. 2 electric-weld pipe mill product at tonnage rates equivalent to maximum welding mill speed. Welded pipe lengths up to 200 ft long are transferred by chain conveyor tables and conveyed through normalizing and reheating furnaces before entering the mill. After the desired outside diameter and wall thickness are obtained, the tube is automatically sawed to desired lengths, kicked off onto a screw type cooling bed where nominal lengths are transferred to further sizing, straightening and finishing functions.

Outstanding features of the new mill are elimination of all roll adjustments, quick change device for roll stands, flying saw with length-measuring electronic control, and extremely accurate speed control. Plans are under way for the addition of two roll stands.

National Tube Div. of United States Steel announced that it will construct a new continuous butt-weld pipe mill at the Lorain Works. Completion is expected in two to three years. The mill will be designed for pipe in a size range of 1¼ to 4 in. Capacity will be 237,000 tons of finished pipe per year. A feature of the mill is a drive which will turn the rolls through a hydraulic slip clutch at the exact rate set by a vernier from a line shaft driven by a variable speed motor. A wide and closely controlled speed range is thus available.

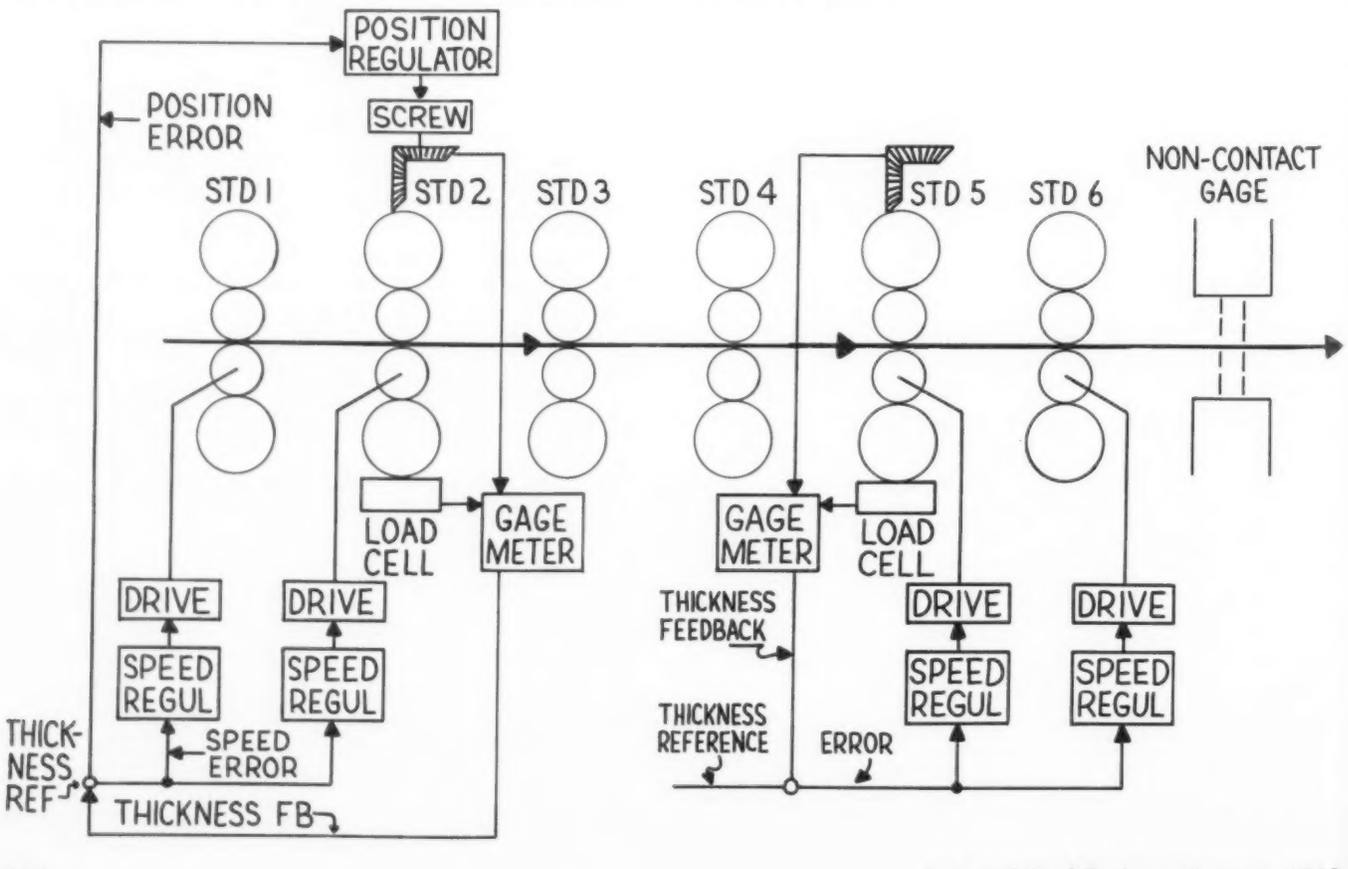
Page-Hersey Tubes, Ltd., officially opened its eighth pipe mill at Welland, Ontario. Built at an estimated cost of $5,000,000, the mill will produce electric-resistance welded steel pipe in a size range from 2⅜ to 8⅝ in. O.D. It has an annual capacity of 120,000 tons of pipe.

The Steel & Tube Div. of Timken Roller Bearing Co. will install a new piercing mill at an estimated cost of $1,500,000. The new unit will be combined with the existing Gambrinus operations to permit double piercing. Completion is expected in July, 1959. The new equipment is part of a $51,000,000 expansion and modernization program to take place in the next five years.

Recent design developments and improvements in equipment for seamless tube mills include a new small diameter, high torque piercing mill roll spindle coupling which has provision for fast disconnect and exchange of universal joint slippers. Another improvement is a radically new single groove roll plug mill with entirely open and easily accessible inlet side, and with a direct roll drive by individual d-c motors. Also, there are a new type of individual reeler drive with slipperless universal joint spindles, new sizing mills of unconventional design with fast schedule change features, and a 3-roll type, 12-stand reducing mill for rerolling of seamless tubing stock.

Republic Steel Corp. started up a new 11-in. bar mill in their Chicago district capable of rolling 3 or 4-in.

Schematic diagram shows operation of a new gage control on 6-stand hot strip mill.



square billets down to ⅜ to 1¼-in. rounds and equivalent sizes of squares, hexagons, special sections and reinforcing bars, as well as flats from 1 to 4 in. wide. The billets are heated in continuous two-zone sloping hearth furnace rated at 85 tons per hour. Natural gas or fuel oil is used with automatic changeover from one to another. Layout consists of 16 stands, straight away. The eight stands of the roughing section and the eight finishing stands are alternately vertical and horizontal. Vertical looping is used between the finishing stands. Each roll stand is individually driven by a d-c motor, ranging from 300 hp on the first stand to 800 hp on the last stand. The motors for the horizontal roll stands are on the main floor and the motors for the vertical stands are located below the main floor. Maximum delivery speed is 3000 fpm. The new facilities cost about $18,000,000.

Wisconsin Steel Works of International Harvester Co. announced plans for a new merchant mill to cost about $12,000,000. The new mill will roll small rounds, squares, flats, channels and angles, and will replace two old mills. It should be in operation in 1961. Capacity will be around 20,000 tons per month.

Completed recently were modifications on existing roll stands of a continuous mill at Northwestern Steel & Wire Co., Sterling, Ill. to permit rolling of universal beams. This is said to be the first installation where wide flange beams are rolled on a continuous mill. The new universal stands were rebuilt from existing horizontal two-high stands. The converted mill can be used to produce angles, channels, plate, etc., by changing stands.

Ceco Steel Products Corp. is erecting an $11,000,000 steel mill at Lemont, Ill. for bar production. It is planned for a capacity of 120,000 net tons per year of billet-sized ingots to be processed into bar products for use by Ceco.

The bar mill will be of cross-country type, and will have one 18-in., three-high stand, one 14-in., two-high stand, four 12-in., two-high and two 10-in. stands. In addition, there is a continuous four-stand, 14-in. train which can be cut into the line for smaller bar sections.

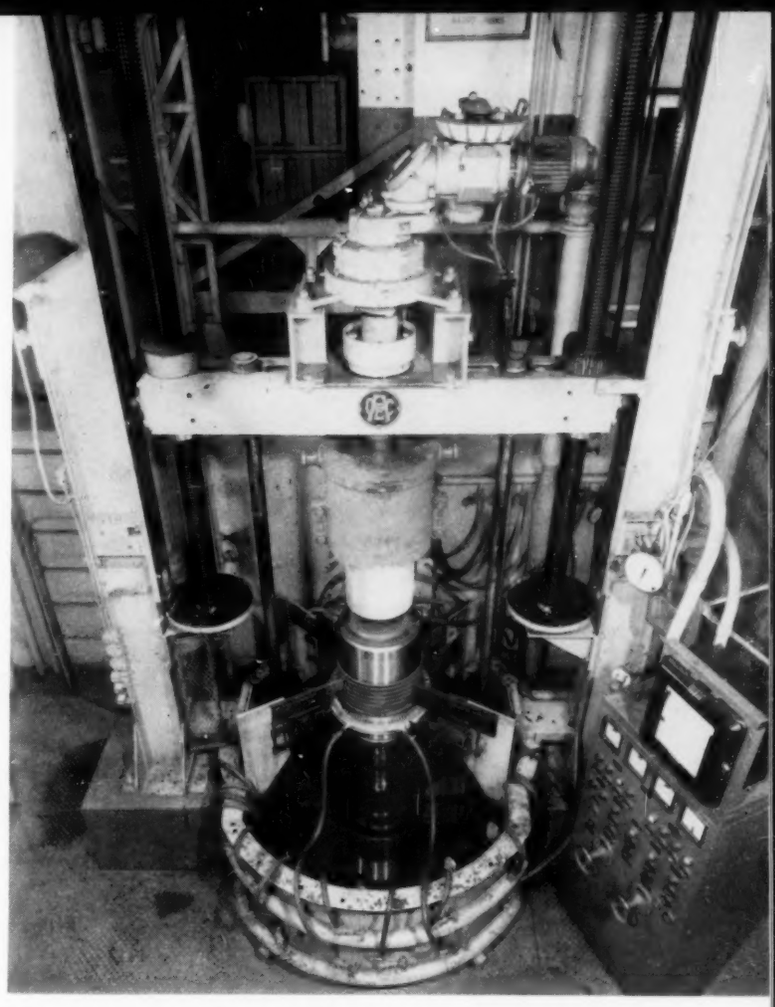
The mill is expected to be in operation by the fall of 1959. It will be able to produce channels and angles, rounds from ⅜ to 2¼ in. in diameter, all sizes of reinforcing bars and special sections.

Sheffield Div. of Armco Steel started construction work on a new $10,000,000 rod mill at Kansas City, Mo. This will be a high speed unit, having a speed of 6000 fpm on rods and a production rate of 80 to 90 tons per hour for bar products.

Transistors are being used in hot metal detectors for a new continuous merchant bar mill scheduled to be put into operation in 1959. The detectors use a silicon solar battery to detect radiant energy and convert it to electrical energy. They replace photoelectric eyes formerly used in such applications.

The signals are amplified by transistor amplifiers to a sufficient level to operate a heavy duty control relay. Response time is less than 1/10 of a second and can be used with steel at temperatures up to 1500 F. Applications include bar turners, repeaters, transfer tables, flying crop shear, dividing flying shear, looping trough and rod coiler guide.

A spring supported roller guide was introduced in this country from Sweden. The unique feature of the guide is the manner in which the rollers are mounted. A leaf spring supports one pair of rollers close to the mill providing a minimum distance from the guide rollers to the mill rolling pass. By mounting the rollers in a leaf spring, the oval may yield and the guide can accept discrepancies in the roll section without cobbling and without placing undue wear on the rollers, bearings and shafts.



Progressive induction hardening gives roll good microstructure.

A new method for hardening rolls is being used in this country, based on progressive electric induction heating. With this procedure it is possible to heat the surface area alone to a temperature above the critical range while maintaining inner portions of the roll below transformation temperatures. Advantages of the process are lower internal stresses and better control of the metallurgical structure.

Improvements have been made in the continuous lubrication of bearing segments of universal mill spindles. Three different methods are in use. They are:

1. A direct spray to the outside of the coupling joints.
2. Oil injection into air, fed internally to the bearing segment faces.
3. Oil mist fed internally to the bearing segment faces.

The second and third designs require the use of stationary collars around the couplings or spindles, properly sealed so that the lubricant can be fed through the stationary collar into the spindle or coupling head, then to the bearing segment.

Since these systems are not dependent upon the rotation of the mill spindles, they will work on nonreversing

Jet bar descaler is effective on flat products.

mills as well as reversing mills. Speed seems to be the only critical factor, as it affects the life of the seals in the rotating collar.

It is reported that slipper life has been doubled. Bearing life has also been increased.

Improvements in hydraulic descaling systems are said to result in improved product quality, reduced water usage and less cooling of the steel during descaling. The use of 2500-psi water pressure and newly designed spray nozzles set up a differential cooling, causing the scale to shrink and separate from the parent metal.

For round or square sections, the jets are arranged in a ring. For flat products, the jets are incorporated into a bar. A definite advantage is the small quantity of water required—only one quart to three pints per sq ft for removing furnace scale from slabs.

At John A. Roebling's Sons Corp., a shot blast unit has been incorporated in a continuous patenting line. Shot blasting has proved entirely satisfactory here. It may be slightly more expensive than acid cleaning but this is said to be offset by less steel loss and by salvage value of the shot.

A hot ingot peeling machine, developed originally for alloy and stainless steels not easily adaptable to flame scarfing, has proved successful in producing a good quality steel at low cost. In this machine, the hot ingot is milled on all four faces. During this process there is a loss of temperature of 100 to 200 F. Ingots may then be reheated for immediate rolling.

The machine consists of the milling cutter, bed and carriage, manipulator and tables, hydraulic power group and control panel. The milling cutter wheel is 7 ft in diameter and contains 48 cutting tools. It rotates at 75 rpm, resulting in a cutting speed of about 1700 fpm. The machine can process about 13 ingots per hour.

Copperweld Steel Co. appropriated $1,325,000 for new facilities at the Glassport plant to produce aluminum-covered wire. The decision to enter full scale production of aluminum-covered steel wire was dictated by favorable acceptance of the product. The process to be used applies both heat and pressure to weld aluminum to the steel which is subsequently drawn into wire. The final wire will have 25 per cent aluminum by area.

FINISHING

At the beginning of 1958 it was estimated that continuous galvanizing sheet capacity was 3,131,000 tons from 32 lines, with perhaps almost another 900,000 tons available from hot dip capacity. This is almost double the continuous capacity which was available only four years ago in 1954.

Tinning capacity was also on the increase with several new lines going into operation at Kaiser and U. S. Steel.

U. S. Steel put one electrolytic tinning line into production at the Pittsburg, Calif., plant of Columbia-Geneva Division. This installation is equipped with automatic closed-loop feedback control to regulate and synchronize most of the line functions. Included are modulated loop controls, both magnetic and photoelectric, and regulators covering speed, edge position, tension, temperature and plating current. All of these regulators are synchronized to the speed of the moving steel.

Also on the line are pinhole detectors, radiation gages for measuring steel and coating thicknesses, flow line indicators, reflectivity devices for surface inspection, and sheet classifying equipment. Control devices provide a maximum degree of accuracy at speeds up to 1250 fpm. The line is designed for differential coating.

A report during the year disclosed a laboratory process for electro-depositing bright coatings of tin. The process requires the addition of a dispersion of wood tar prepared with a selected surface-active agent to an acid stannous sulphate electrolyte. Efforts have been recently made to develop sources of supply for the wood tar from wood distillers, and the material is now available for trial.

A modification program at Irvin Works will enable U. S. Steel Corp. to enter into the aluminum-coated steel sheet market. Plans call for alteration of the 48-in. light gage continuous hot dip galvanizing line to produce aluminum-coated steel sheets, 18 gage and lighter. Completion of this program is expected late in 1959.

A co-operative program on the part of six steel companies and a manufacturer to investigate the Ruthner method for recovery of waste pickle liquor is well on its way, and an extensive report on this program was given during the year. This report, based on operating results of a pilot plant developed economic factors for a hypothetical plant capable of treating 100,000 gal per day of pickle liquor containing 8.5 per cent free sulphuric and 13 per cent ferrous sulphate. According to the report the cost for treatment would run about $0.0129 per gal compared to $0.027 by lime neutralization. Capital investment for this plant would be about $4,449,000. Annual operating costs are estimated at $1,217,830 with credits of $776,334, giving a net annual cost of $451,496, compared with a net annual cost for lime neutralization of $953,650.

Summarizing, the advantages of the process are: (1) the entire sulphate equivalent of the waste pickle liquor is recovered as a reusable sulphuric acid without the use of a contact sulphuric acid plant; (2) the only by-product obtained is iron oxide which is of high quality and, when sintered, can be recharged to the blast furnace; (3) the process can handle high acid strength waste pickle liquor.

Another process for regenerating pickle liquor is receiving some interest. This is the ferrous sulphate

monohydrate process in which spent acid is pumped to an atomizing spray head in a large evaporating chamber, where it meets a blast of hot air or flue gas. The heated mixture causes evaporation of water from the hot liquor, thereby concentrating the free acid. The vapor-laden air is discharged to the atmosphere through a mist eliminator and stack.

Because of the solubility characteristics of the ferrous sulphate-sulphuric acid system, the weight of salt held in solution decreases as acid concentration increases. The high temperatures assure production of monohydrate rather than heptahydrate. This initial concentrating process causes only 40 per cent of the ferrous sulphate to crystallize out of solution.

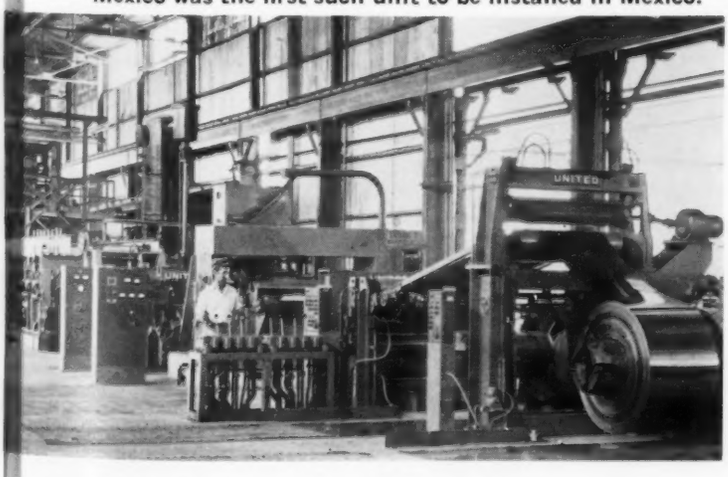
The slurry is dropped into a crystallizing tank where 66 degree Bé sulphuric acid is added. This make-up is no more than that actually consumed in the pickling reaction and in rinsing. Acid concentration is raised a second time, thereby dropping out more ferrous sulphate monohydrate. By these two steps, salt concentration is so reduced that on ultimate dilution to correct pickling strength, the regenerated liquor will contain no more than two per cent iron.

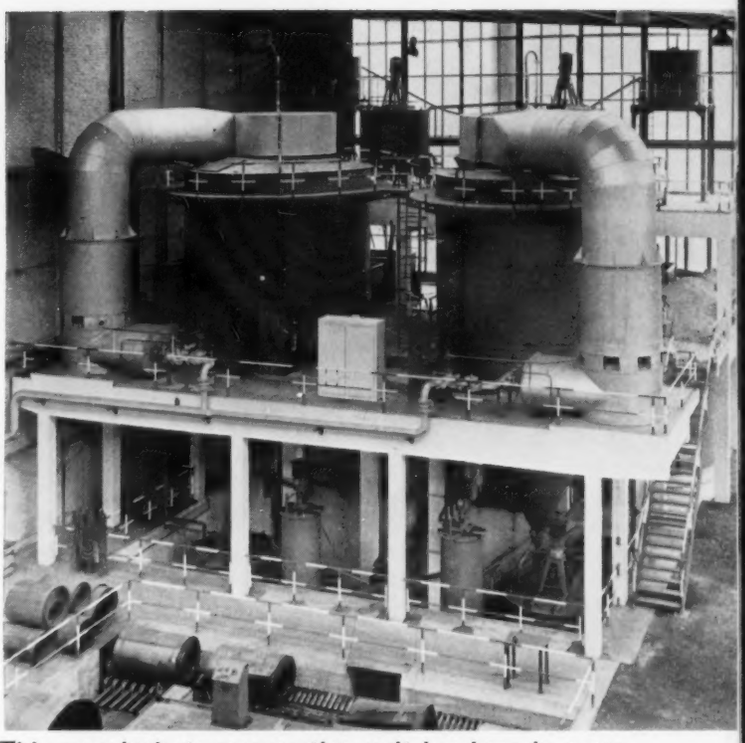
Slurry is separated in a vacuum filter or centrifuge and washed to remove residual acid. The dried salt is then conveyed to bins. A mother liquor which contains about 35 per cent sulphuric acid is pumped to a holding tank from which it may be metered directly back to the baths along with the calculated quantity of dilution water from the rinse tank. A 48,000-gal per day plant using this process has been in successful commercial operation in Germany for over four years.

This particular process or regeneration requires an investment ranging from $700,000 for 20,000 gal per day capacity to $1,300,000 for 100,000 gal per day capacity, but is able to show net operating costs after 15-year depreciation ranging from 1.5 down to ¼¢ per gallon at the higher throughput.

Another American company acquired world rights for a process for the reclamation of pickle liquor. This is the Belle Fons process which recovers and regenerates waste pickle liquor at temperatures 100 F below other known methods. This technique regenerates spent acid and consists essentially of—evaporation of water from spent acid, addition of fresh acid to crystallize the ferrous sulphate or suspended matter, and separation of solids from regenerated acid that is reused in the continuous cycle.

New 38-in. electrolytic tin plate line at Altos Hornos de Mexico was the first such unit to be installed in Mexico.





This monohydrate regeneration unit has been in operation for some time in Germany.

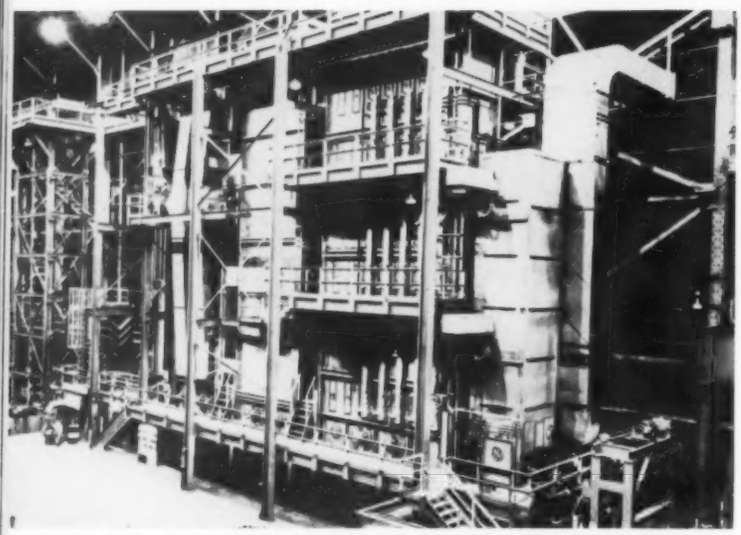
Two designs using the same chemical reactions are available—one with a capacity of 18,000 gal per day, and another for 30,000 gal or more per day.

Some of the features of the process are low operating and maintenance costs, compactness, simplicity, recovery of more than 98.5 per cent free acid, constant pickling efficiency at any acid strength, and direct and simple ferrous sulphate removal using no contaminants or elements foreign to the pickling process.

Still another low-cost method now in operation uses lime for neutralization and produces a by-product which has been found suitable for land fill. The process uses a slurrying tank, a reaction tank and a vacuum disk filter interconnected by pipelines. The principle is continuous neutralization and controlled oxidation of the liquor. The filter cake can be used for land fill and the filtrate can be discharged to sewers. One plant initially installed in 1951 is now able to treat at least 60,000 gallons of waste pickle liquor in 8 hours, producing 300 tons of filter cake. The company's waste output runs from 4,000,000 to 6,000,000 gal a year of two to five per cent sulphuric acid and 25 per cent ferrous sulphate. It is estimated that a duplicate plant would cost less than $100,000. Operating and disposal costs, including plant depreciation are under 2¢ per gal. An important factor on cost is the neutralizing agent which is used. Both limestone and calcium hydroxide have been tried.

FURNACES AND CONTROL

In the furnace field, the continuous tinplate annealing lines continue to hold an important spot. About 15 such lines are now in operation in the United States and Canada and another one is under construction. With this number in operation, some trends are evident. As would be expected, trends are toward higher speeds and increased capacity. Of the lines which have a



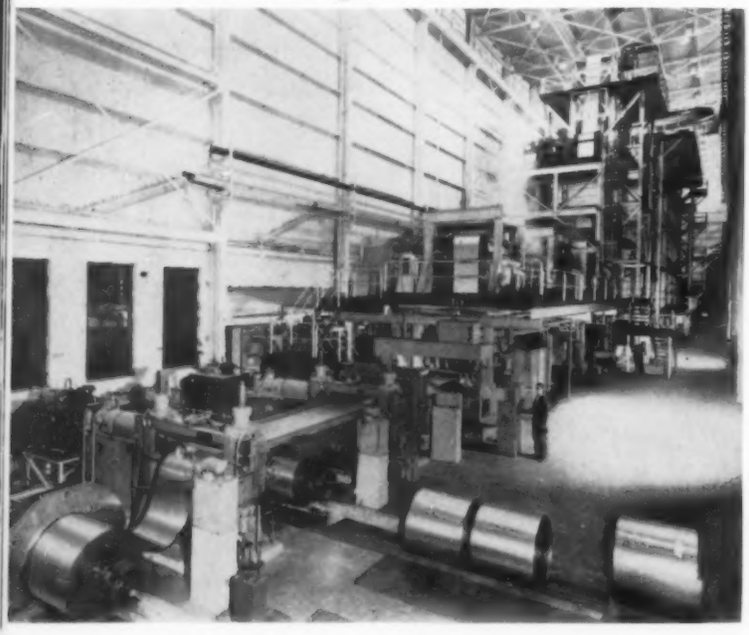
The new continuous annealing line installed by Youngstown Sheet and Tube Co. at their Indiana Harbor works is so designed that later increase in capacity can be readily attained.

nominal speed of 1000 fpm or greater (these include three 1000-fpm, one 1500-fpm and one 2000-fpm line) all use combination gas-electric heat. All of these lines also use radiant tube recuperative firing. Of these five lines, two use a water quench and three do not.

The furnace atmosphere now used consists primarily of a purified mixture of about 95 per cent nitrogen and 5 per cent hydrogen dried to a dew point about −50 F. Generators are being supplied with top ratings up to about 20,000 cfhr although inquiries are being received for units up to 40,000 cfhr. In one steel plant some of the annealing atmosphere comes from by-product nitrogen made by oxygen generators.

It is reported that an accelerated cooling system under development for continuous tinplate annealing furnaces will be up to 50 per cent shorter in length than the conventional cooling systems and will permit an over-all reduction in furnace length.

Three continuous annealing lines are under construction for the United States Steel Corp. which are similar to the unit shown in this figure.



The newest continuous annealing line to go into production is a combination gas-electric furnace installed by the Youngstown Sheet & Tube Co. at their Indiana Harbor Works. The new furnace is rated at 15 tons per hour at 500 fpm of 0.01 x 30-in. strip. An interesting feature of the design is the provision made for later expansion. When eventual conversion is made, capacity will be increased to 30 tons per hour at a maximum speed of 1000 fpm.

Jones & Laughlin Steel Corp. announced plans for a modern high-speed continuous annealing line at the Aliquippa Works to be built at an estimated cost of over $7,500,000. This line is being engineered to operate at speeds up to 2000 fpm. The plant is scheduled for completion in 1959.

An unconventional development for continuous annealing of strip steel uses liquid sodium as the heat transfer mechanism. Because of the high heat transfer rate (several hundred times conventional), total strip travel of 30 ft in a furnace using a sodium bath is said to give strip properties equal to or better than those from the conventional radiation tube type annealer with about 2100 ft of strip travel. Fuel consumption on the other hand should be only about 15 per cent that of the conventional furnace.

The apparatus consists of a bath of molten metallic sodium with gradations of temperature from about 300 F at the place where the strip enters the sodium to about 1350 F maximum. After reaching annealing temperature the direction of travel of the strip is reversed and it travels back through regions of decreasing temperature in the sodium, giving up most of its heat to the incoming strand of strip and leaving the sodium bath at about 300 F. This is below the temperature at which an observable oxide film will form on the strip surface.

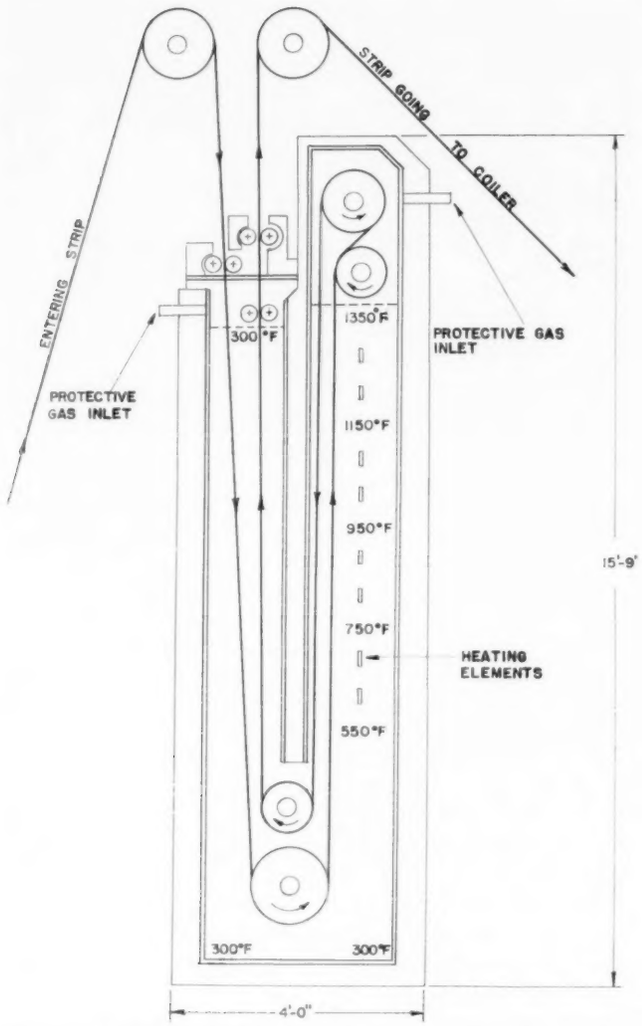
Because of higher transfer coefficients, a sodium bath annealer, at 1000 fpm, handling tin plate stock 0.010 in. thick, 32 in. wide, need not be more than about 15 ft high, 6 ft long and about 4 ft wide. It will have an output of over 30 tons per hour. The strip can be raised to the annealing temperature very quickly or in two seconds or less.

In recent years there has been some question of age-hardening in connection with continuous annealing of low-carbon strip. To develop information on this, extensive laboratory tests were made with test runs of one, two and three seconds time of immersion in sodium at 1330 F using cold-reduced low-carbon strip 0.010 to 0.011 in. thick.

These test results show that all of the specimens were actually softer after 36 days than immediately after they were annealed. In addition, only 10 sec slow-cooling time is all that was needed even for this rather hard-to-anneal steel.

It is believed that the process can be advantageously combined with continuous hot-dip galvanizing, as the sodium so thoroughly cleans the strip surface that no flux whatsoever is needed.

A new technique in coil annealing was announced during the year in which the coils are opened, or "loose wrapped," so that the furnace atmosphere penetrates the wraps, speeding up heat transfer and reducing annealing time.



The use of molten sodium for continuous annealing makes possible a design requiring much less outlay in capital equipment and permits faster annealing.

It is claimed the open coil annealing system should save more than $2 a ton on annealing costs. Capital investment is estimated at one-third of the conventional batch annealing.

In the process, coils from the cold mill are rewound in a vertical position with a nylon string interleaved through them. When the string is pulled out, the coil turns are separated by the thickness of the string.

The open coil remains on its side in the next part of the process. First it goes to a station where cleaning can be done by dip, vapor or hot gas method. The coil is then ready for annealing and it is moved to a purging chamber where the air is driven out of it. It then goes into a rotary hearth furnace with seven zones: two preheating, two heating, one soaking and two cooling. A recuperative system transfers heat from the cooling to the preheating zones. The furnace indexes on a time cycle of one zone every hour or less, depending on stock thickness. The full 7-hour cycle delivers the coil from the furnace cool enough for rewinding and immediate temper rolling. The annealing rate is about one coil or about 25 tons of steel an hour.

Spurred on by competition, the direct-fired cover type furnace has received a great deal of attention in the attempt to increase heating efficiency and reduce maintenance cost.

A leading southern steel plant recently installed a group of direct-fired furnaces for tinplate annealing with eight pedestal units holding 32 coils. It is reported that this unit gave a 60 per cent reduction in the cost per ton of steel annealed compared with similar furnaces fired by other methods. One factor is an aluminized protective coating which raised the service life of the mild steel innercover to 550 heats. This coating is applied by metal spraying over a sandblasted furnace.

A bloom reheating furnace, designed to heat blooms while in transit between mills, is said to have paid for itself in 1½ months by eliminating two handlings of hot steel by mechanical manipulator. The unit consists of nine barrel-type units which form an integral portion of the conveyor system between the blooming mill and the rail mill. Batch-type long cycle furnaces which were formerly used and which needed feeding and removal of billets have been eliminated.

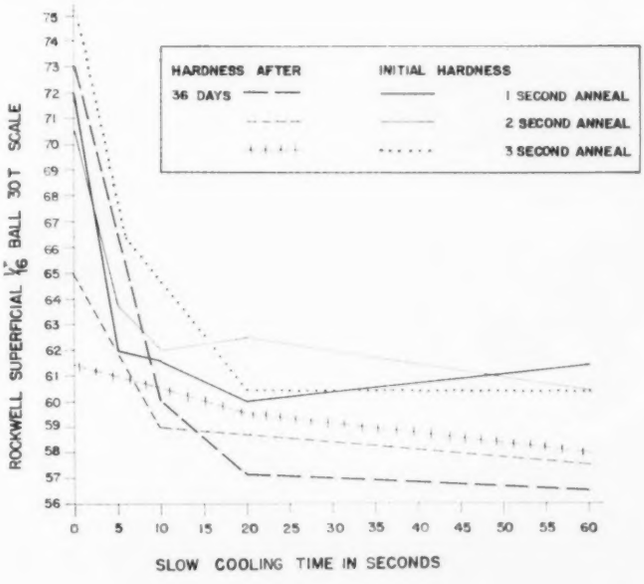
The new unit is capable of reheating blooms weighing up to 9050 lb at rates up to 198 tons per hour. The furnace line can release a bloom automatically at a signal from the rail mill operator. A cool bloom is accepted whenever space is available.

The Youngstown Sheet & Tube Co. increased their soaking pit capacity at Youngstown without expanding existing buildings by replacing two rows of four small gas-fired regenerative pits with two rows of three larger one-way top-fired recuperative pits. Each row has its own metallic recuperator. A high velocity combustion system was used. After one year, the operators report that the installation is operating satisfactorily with a minimum of maintenance.

The new soaking pits at the Steel Company of Canada's new 46-in. blooming mill have some interesting features. These pits are 18 ft square and 11 ft 6 in. deep and hold an average of 150 tons of ingots each. They are of bottom center-fired design.

There are two double compartment recuperators for each pit, built of a silicon-carbide refractory. An

One of the things which will make annealing with molten sodium practical is that there is no age hardening effect despite the fact that very fast annealing times are used. Test curves actually indicate softer metal after 36 days than initially.



unusual feature is that the pits are designed to use a wide variety of fuels, as conditions dictate. The operator may choose straight coke oven gas, mixed coke oven and blast furnace gas with any calorific value between 150 and 300 Btu per cu ft or blast furnace gas of 90 Btu per cu ft.

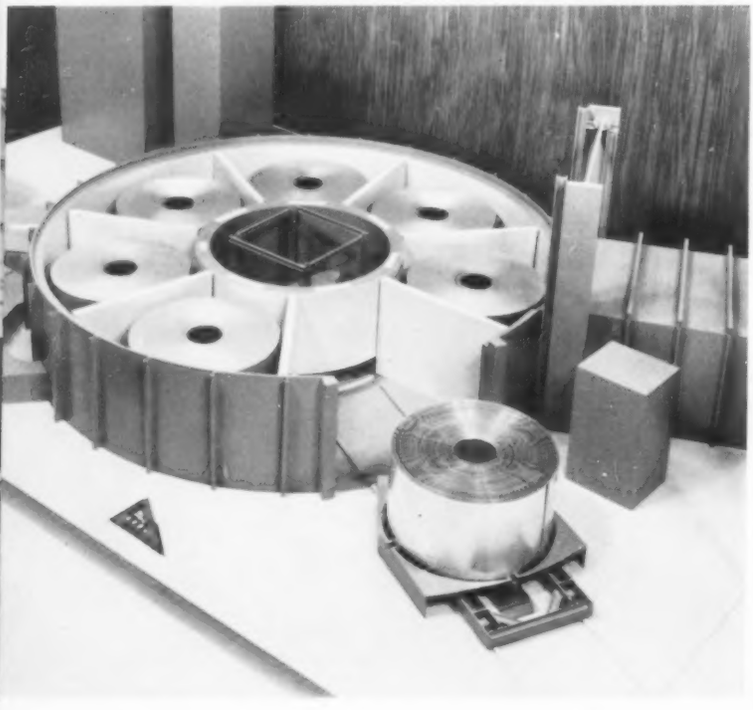
Jones & Laughlin Steel Corp. has installed a new combination continuous heat treating and normalizing line at its stainless steel plant at Detroit, Mich. The installation includes two new furnaces, making it possible to supply stainless steel bars in a wide range of hardnesses to meet customer specifications. About 100 ft long, the line can heat treat stainless steel bars in sizes from ½ to 4½ in. in diameter in lengths up to 30 ft.

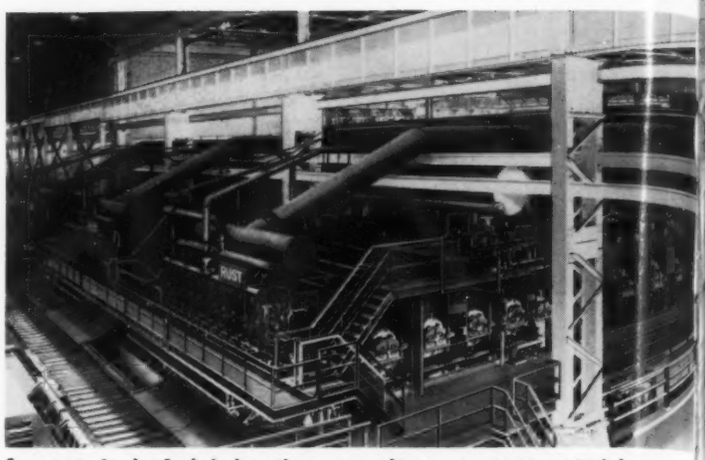
Inland Steel has placed a contract for the design and erection of two 4-zone reheating furnaces for their structural mill. These furnaces will operate on coke oven gas or fuel oil. Each furnace will be rated from 75 to 120 tons each per hour. The furnaces will have 72 x 24-ft hearths. Recuperation will be included to preheat combustion air to 750 F.

Steam is ordinarily used to atomize liquid fuels for open hearth furnaces but the steam depresses maximum flame temperature, which in turn limits the amount of heat theoretically available for transfer to the bath. Other gases such as air, natural gas, coke-oven, blast furnace gas and even oxygen have been substituted for steam. Jet atomization with reaction jet burners has attracted attention. Results of tests have shown higher flame temperatures and up to 30 per cent higher firing rates with excellent flame propagation, and increases in production up to 12 per cent.

Atomization of open hearth fuel oil with high pressure gas results were reported at the 1958 AISE convention for the Houston plant of Sheffield Div., Armco Steel Corp. The changeover from steam resulted in substantial fuel savings. The flame appearance with high pressure gas is shorter, brighter and less dense than when atomizing with steam. The flame is three per cent hotter than the steam-atomized flame. Gas pressures at the burner range 175 to 185 psi.

Top of model furnace has been removed to show movement of coils in new open coil annealing system.





A great deal of slab heating capacity was constructed in 1958. This unusual photograph shows the new unit for Kaiser's 86-in. hot strip mill. Each furnace is rated at 150 tons per hour.

With similar firing rates, some comparative results are: a five per cent increase in tons per hour with five per cent less hot metal; a decrease of 380,000 net Btu per ton; a fuel cost advantage of 44¢ per ton; an increase in furnace life.

The Empire-Reeves Steel Corp. also converted their basic open hearth furnaces at the Mansfield, Ohio, plant from oil-steam to oil-natural gas firing. They report increased production, improved product, increased fuel input and lowered flux requirements.

Natural gas under high pressure (200 psi) is used to atomize the fuel oil as it is injected into the furnace. Fuel proportions run 90 per cent gas and 10 per cent oil at the beginning of the heat. During the refining period when the firing rate is reduced about 20 per cent, proportions are modified to 50 per cent gas and 50 per cent oil. Another advantage is that a large part of the heat input is supplied by sulphur-free gas, resulting in lower sulphur content in the steel. It is reported that the cost of conversion was recovered in savings in the first month of operation. Fuel savings alone were 23 per cent.

Granite City Steel Co. and Wheeling Steel Corp. are also trying out natural gas firing. Granite City Steel reports that this has increased steel tonnage from 17.1 tons per hour to 20.5. It has dropped fuel consumption from 4,100,000 to 3,600,000 Btu per ton.

Continuous oxygen analysis has been found very effective in combustion control in the open hearth. Such equipment has been in operation for some time at the Geneva Works of U. S. Steel. Originally a continuous waste-gas analyzer was put on their No. 6 open hearth furnace and because of the excellent results, an additional unit was put on No. 8 furnace. Compared with the other furnaces in the shop, production rates in these two units are higher and fuel consumption is lower. The original installation plan was to completely eliminate the existing fuel-air ratio control and to directly set combustion air flow from waste gas analysis. This end point control has operated most satisfactorily

with oxygen content in the waste gases controlled to very close tolerances.

As a result of the initial work, the entire shop was equipped with waste gas analyzers.

A unique industrial oil-gas burner, a radiant pulsation type, produces a powerful luminous flame with a peak temperature of 3450 F when burning oil and above 3300 F with 1000 Btu per cu ft natural gas. The burners are available for heat release rates ranging up to 70,000,000 Btu per hr. Efficient combustion is achieved by a pulsating flame which is enhanced by catalytic action of a special refractory liner. Fuel savings over conventional burners are said to range from 12 to as high as 30 per cent. The flue gas is exceptionally clean and has no carbon monoxide.

This burner uses 3-psi compressed air to atomize fuel metered into the air stream, and the flame which is produced is actually a steady, extremely rapid series of explosions similar to a jet. The result is efficient combustion of the air-fuel mixture without smoke, soot or carbon build-up. The flame is readily controlled by adjusting fuel and air flow.

The use of precast panel construction on furnaces has expedited several installations. Several car-bottom furnaces were erected, using a patented precast insulating refractory panel assembled to prefabricated steel work with all-bolted construction. The result is a thin-wall, individually supported furnace lining. Erection is fast and erection cost is low.

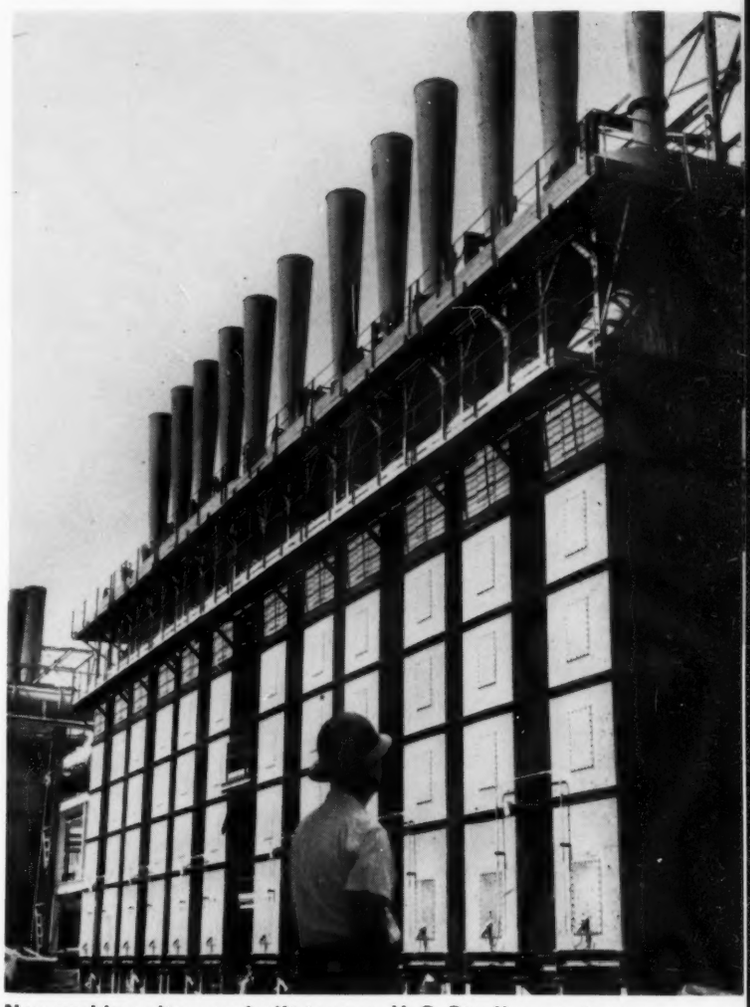
It is reported that a new type instrument has been developed which will rapidly measure the temperature of any solid, liquid or luminous flame in the 1500 to 4000 F range without making emissivity corrections. Accuracy is claimed to within 20 F. As an example, the instrument will measure the temperature of flowing molten metals, or of moving objects in a furnace rather than the furnace temperature. The unit is a radiation ratio pyrometer consisting of a sensing head for detecting radiation, and a control unit which interprets the information.

MATERIAL HANDLING

One of the largest ladle cranes on the boards will be built for the Fairless Works of United States Steel Corp. This is a 525-ton unit. The design incorporates the use of special alloy steels where practical, and the ladle hooks will be made of high tensile steel (T-1). As a result, the crane can be installed on existing runways which now carry 450-ton cranes.

The main hoist is the interlocked drum type with synchronized worm drive equipped with two motors. The main trolley has 16 track wheels, equalized by special truck construction which affords transverse and longitudinal equalization. The truck wheels are located directly over the web plates, thereby reducing stress in the top cover plates. The bridge operates on 32 double flange track wheels, housed in 16 trucks. About 1500 hp will be used to drive the crane through 10 motors.

A very large soaking pit crane is being built for the Lukens Steel Co. This will be a 75-ton unit with a 10½ ft tong opening. Space-saving front-connected d-c crane control panels will be used, requiring no rear access. This permits a reduction of 24 in. in the required bridge approach distance.



New soaking pits were built to serve U. S. Steel's new structural mill at the South Works.

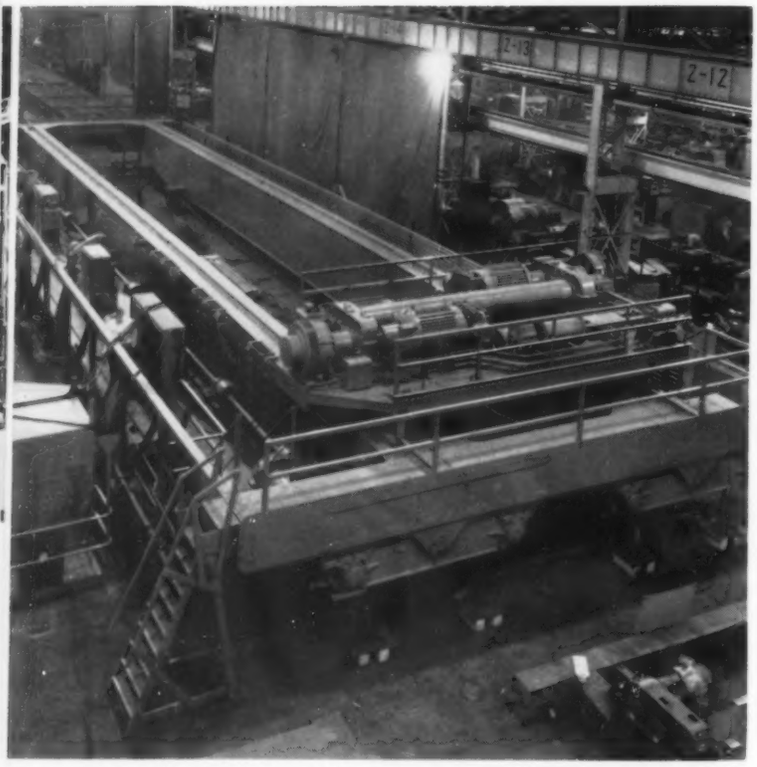
Another feature is a trolley slow-down zone at both extremes of the bridge ends, accomplished through control circuitry which automatically applies an armature shunt in conjunction with the proper series resistance for slowdown. The wide tong-opening range of 2½ to 10½ ft is made possible by the use of interchangeable tong heads.

There is a great deal of interest in a new electronically controlled steel mill crane installed in the Ohio Valley district. This type of control has a wider speed range than d-c control, and its selection eliminated the necessity of providing a source of d-c power supply.

The crane is a 20-ton unit with 100-ft span and 16-ft spread. The hoist is a dual unit rated at 140 fpm with two 125-hp, 900-rpm motors. The electronic control which provides reversing plugging for both bridge and trolley is stepless. A magnetic torque unit is provided on the hoist which gives a specified speed of 8 fpm on the first step lowering at full load of 20 tons.

Equipment has been developed which will enable a single trolley on a crane to be used as a double hoist. This permits operation at slow speeds to lift heavy loads and at fast speeds to lift light ones. The conversion from one capacity to another is achieved through a quick and simple connection or disconnection of two sections of the hoist block.

In conjunction with the new 80-ton oxygen converters being installed at McLouth Steel's Trenton plant, a key



Developments in alternating current crane control indicate that much more extensive use will be made of this type of equipment in the steel plants of the future, particularly at locations where d-c power must be developed.

piece of auxiliary equipment is a crane which carries a smoke hood and smoke-hood hoisting arrangements, lance hoists and lance clamping devices. The entire unit rotates to move the smoke hood from the top of the furnace when charging or pouring.

A third man-trolley ore bridge also will be built for McLouth, identical to the two now in use. It will handle 1050 gross tons an hour from the boats to the stockpile, and will also reclaim ore and limestone from storage. The bridge will be 545 ft long with a 350-ft span between the legs. At the pier end, a hinged apron will extend 120 ft over the river. The shear leg and cantilever of the bridge will extend 75 ft over ore transfer tracks. Bucket hoisting speed will be 300 fpm, trolley speed, 985 fpm. Normal bridge travel speed will be 90 fpm.

Inland Steel Co. awarded a contract for a new ore bridge at Indiana Harbor Works, duplicating their No. 9 bridge which went into operation early in 1957. The new unit will increase Inland's ore handling capacity to the level required by a new ore screening and sintering plant.

Developments in electronic equipment have accelerated the trend to weighing and proportioning material continuously without slowing down operation. Not only is it possible to measure weights, it is also possible to tie the weight measurement in with controls which will set up proper proportions, proper flow rates and speeds of operation.

As an example, at the Cleveland Works of the Jones & Laughlin Steel Corp. a system was set up in the new sinter plant which automatically weighs and proportions the right amount of iron ore fines, coke breeze and flue dust. The key item, of course, is the electrical weighing setup.

In the setup, the three major parts are an electric tachometer which computes belt speed, an electrical strain gage load cell which measures belt load, and a potentiometer which indicates and records instantaneous flow in tons per hour. A counter can also be tied in with this unit to show tonnage. In this sinter plant setup, there are 12 automatic weighing units which check the moving materials at every important stage of the sintering operation.

Jones & Laughlin Steel Corp. have also installed an automatic proportioning system to mix coals from two company mines—the Shannopin Mine and the Vesta Mine. The system is regulated by automatic electronic weighing, and has given a high degree of uniformity in the mixed coals.

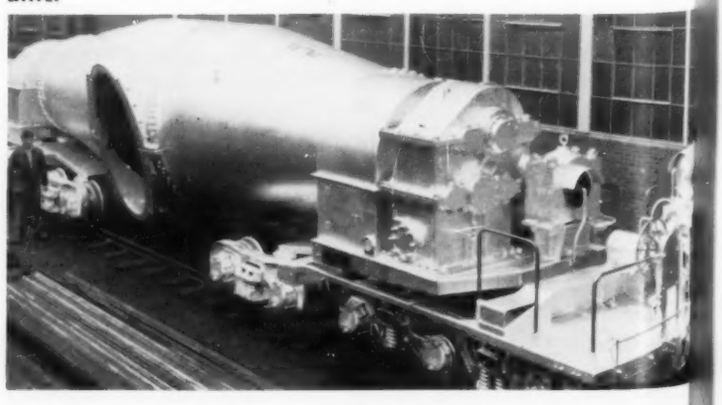
A modern 150-ton welded hot metal transfer car, one of five units going into an eastern steel plant, uses two sets of six-wheel trucks and two sets of four-wheel trucks to maintain low wheel loadings. Weight reduction was obtained through the use of a high tensile alloy steel with strengths up to 100,000 psi, and ductile iron. There was a total saving of some 66,000 lb in the car. The design uses spherical trunnion bearings to control misalinement, all-welded ladle barrel for easier lining application and longer life, and centralized lubrication.

An interesting piece of equipment is the remote control mining machine which permits men to mine coal without going underground. It is designed primarily to mine coal in the high wall of a strip mine to a depth of 1000 ft or more. However, the developers believe it can be made applicable to underground deep mines in the next 10 years. The equipment has a sensing element which will electronically report to the operator outside the mine whether the machine is properly heading into coal. Thus, the operator can guide the machine to follow the coal seam. A prototype machine has been able to advance an entry at a rate of more than 100 ft per hr. The machine automatically loads coal onto a continuous transport system that follows the machine into the mine and delivers the coal to an outside discharge station.

MECHANICAL

In the power plant field, work continues on new designs and improvements and studies for the production of power from the atom. Despite a great deal of progress, there is little likelihood that the atom will be used

New 150-ton hot metal transfer car incorporates many features in the design to reduce the dead weight of the unit.



to generate power in the steel plant in the foreseeable future.

However, at the United Nations International Energy Conference a movie was shown by the Russians of a nuclear power plant in Siberia which is rated at 100,000 kw. This makes it probably the largest one in the world and well above the 60,000-kw unit in operation at Shippingport, Pa. The Russian unit is reported to be the first of six identical reactors to be built at a Siberian power station which will have a total generating capacity of 600,000 kw when completed. The Russians report that the unit produces steam at a temperature of about 365 F, well under the 500 F reported in the United States.

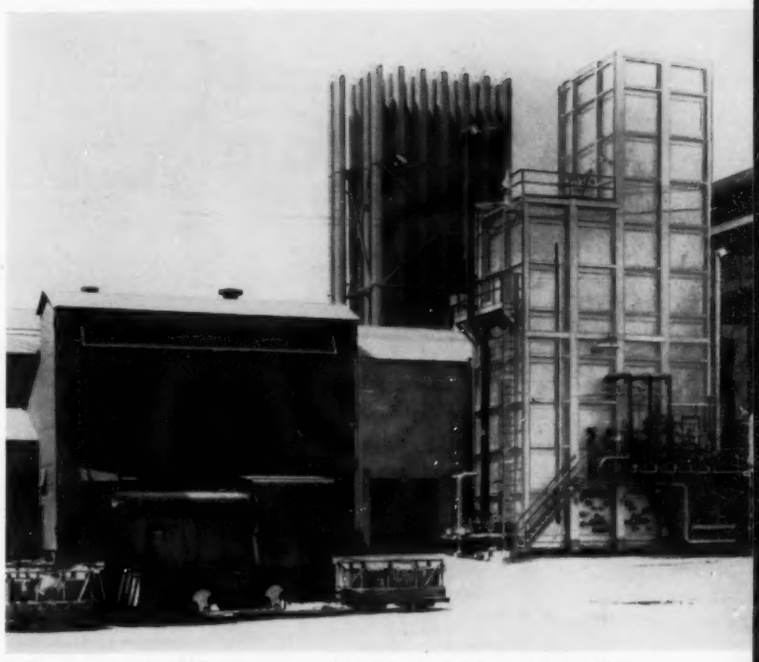
One item holding back atomic power development in this country is the over-all cost of plants, which has been much higher than originally estimated. Some of this may be attributed to greater factors of safety and more elaborate precautions than might later be found necessary.

The Shippingport pressurized water reactor plant is estimated to have cost $121,400,000, of which $98,400,000 are Government funds, $22,500,000 are from Duquesne Light Co., and $500,000 from Westinghouse Electric Corp. Although this plant is rated at 60,000 kw, it is believed that it will ultimately operate above this figure. Of the cost of this plant, $48,900,000 is the estimated development cost for the reactor plant, initial reactor core and some advanced development work. Estimated power cost for this plant is 64.4 mills per kwhr. Of this 22.7 mills is charged as capital investment, 43.4 mills as fuel and 3.3 mills as operational cost. A fuel credit of 5 mills gives a net cost of 64.4 mills per kwhr. In this estimate, the fuel cost is taken at $16,000 per kilogram for highly enriched metallic uranium.

In steel mill power plants, there is a trend to higher pressures and temperatures, larger capacity and more efficient equipment. Present designers are expecting steam conditions on the order of 1250 psig, 975 F to become fairly common in the larger steel mills. Except for special designs needed to burn blast furnace gas, steam generating equipment for the steel mill plants will not differ radically from other units of comparable size. Because of the decreased availability of by-product fuels and the increased cost of purchased fuels, fuel and operating departments are striving to improve station heat rates and to use steam and electric power more efficiently.

In the last ten years there has been considerable development of gas turbines as prime movers for electric generation. To date, the largest unit built in this field has a capacity of about 27,000 kw.

A patent was issued during the year on a process for making ceramic-clad metal structures which combine the temperature, corrosion and oxidation resistance of ceramic materials with the structural strength of metals. The patent covers electrophoretic deposition and bonding of ceramic materials to a metal body by interposed graded coatings of metal and ceramic materials. In electrophoretic deposition, an electrostatic field is established between two electrodes immersed in a colloidal dispersion of charged particles, causing migration of the suspended particles to one of the electrodes. These particles produce an adherent coating on the electrode. When a mixture of metallic oxide or ceramic



A large number of oxygen units were under construction in 1958.

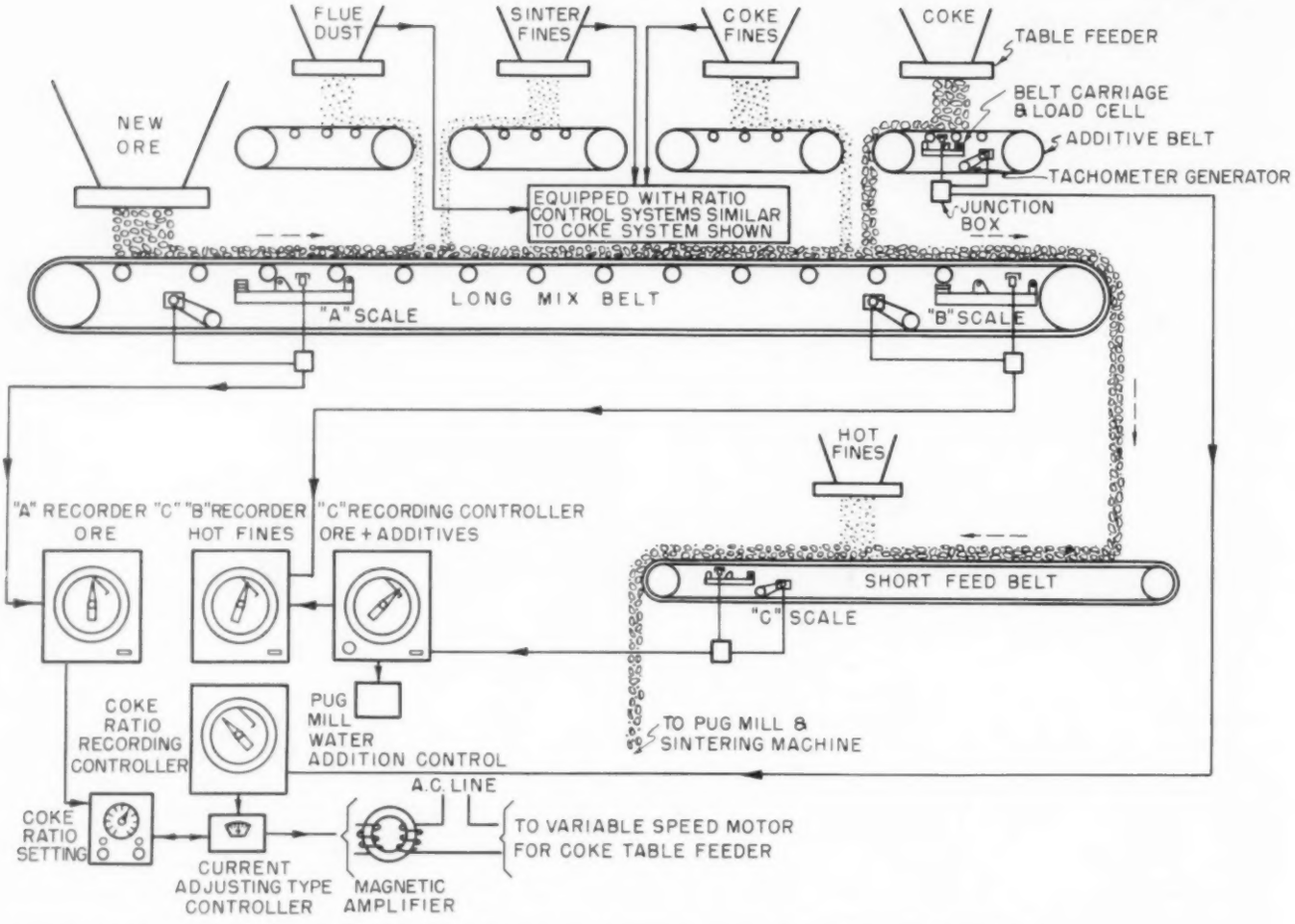
materials is deposited by this method on the surface of a metal body, the oxides are then reduced to metal by firing in a reducing atmosphere at high temperatures, forming a sintered metal matrix which is chemically bonded to the body. The sintered ceramic materials entrapped within the pores of the matrix form a cermet which retains the structural strength of the metal and oxidation resistance of ceramic at temperatures over 700 C.

An interesting application which may reduce corrosion problems is the use of highly corrosion-resistant resins and puttys. These were originally developed for aircraft and missile applications but are being used by utility companies to reduce maintenance costs in such applications as sea water pumps. A room-temperature setting special putty formula is used which fills pits and channels in the diffuser vanes and housing of the pump. A special liquid resin protects built-up areas against sea water corrosion and abrasion.

An improvement in wrought iron metallurgy has resulted in a new wrought iron with superior resistance against many kinds of corrosion from industrial atmospheres, acid solutions, salt water and steam condensate. This improvement has been achieved by a substantial increase in the deoxidation of the base metal, and by increasing the phosphorous content.

A new cyclic welding process seems to have some advantages, particularly in maintenance applications. The welding is done at controlled rates based on the thermal transformation diagram of the material being welded. Cooling rates are combined with precise preheat temperatures and with continuous repeated stress relief. By rigid supervision of procedure and material selection, excellent welds are obtained regardless of the mass of the weld metal deposit, thickness of members joined or alloy composition of the metal. It can also be applied in restrained areas and in any position in the field or shop with a minimum of disassembly.

Three new processes for welding aluminum were revealed during the year. Their development followed



Automatic weighing and blending will become standard features in steel plant material handling.

several years of research into the causes of porosity in aluminum welds where hydrogen was found to be a major offender. In one process, a trace of chlorine with argon in the contact tube and normal shielding flow in the outer cup provide high quality welds in a flat position. In the second process, low flows of argon in the contact tube and nitrogen in the outer shield provide a low cost means of welding pure aluminum. In the third process, a low flow of argon with a low flow of argon or helium in the outer shield gives all-position, all-alloy code quality welding at lower cost.

The first electronic line tracer for flame shape-cutting machines significantly reduces the cost of pattern preparation, and eliminates the need for costly templates. The unit is an adaption of a newly developed optical sensing system which steers metal-cutting torches by scanning or reading ordinary pen or pencil line drawings. With the new tracer, simple drafting-room type pencil drawings, with lines no more than 0.04 in. wide are all that are needed for the photo-transistor scanner to follow at speeds as fast as the thickness of metal requires.

A new torch known as the plasma torch has been developed which will produce temperatures over three times that of the oxy-acetylene flame. The new device is capable of sustained operation up to 20,000 F and higher. Plasma in this case is a gas heated by electricity to such high temperatures that its molecules are broken down into ionized atoms which have a high energy content. It is formed by passing the gas through an electric current in a restricted passage. The cost of the gas for this torch, plus the electricity, is said to be about half that for the operation of a conventional oxy-acetylene flame. The higher the arc intensity per unit of gas flow, the greater the resulting temperature of the plasma, which is ejected as a jet flame.

Presaging life as a space man is a project under way at Universal-Cyclops Steel Corp. at Bridgeville, Pa. This company is building a full-sized fabrication plant which will be sealed within a building filled with argon gas. This division will fabricate exotic metals and special super-high temperature refractory and reactive metals and alloys. Inside this plant men will wear specially-designed space suits as they work. Entry into the room will be through a lock system. Hoses to each suit will feed in conditioned air and exhaust carbon dioxide to the outside, as even the workers' exhalation would contaminate the 99.995 per cent pure argon gas. Estimated cost of project is $3,000,000.

A new technique for large scale metal forming uses explosives. The explosive charge, a shock transmitting medium and the object to be formed are all contained within a constraining die. The force of the explosion contained within the unit shapes the metal piece into the desired pattern.

The procedure may mean savings to industries which have had to make substantial capital investments for hydraulic presses and other equipment. The process

increases strength of the metal up to 30 per cent. The process is particularly adapted to specialized shapes where large production runs are not involved.

The tremendous hitting power of the explosive chemicals is much higher than the strongest press which can be developed. Pressures up to 7,000,000 psi can be produced, compared with a maximum of about 400,000 psi in a large press.

One program practically common to all steel plants, regardless of location or product, has been development of oxygen supplies.

There seems to be no pattern as to the most economical method of furnishing the required oxygen, the final answer depending primarily on local conditions. In some locations, the trend is to steel plant owned-and-operated units. In other locations, off-site units built and operated by an oxygen supply company seem to be preferred. Some newer facilities built on or adjacent to steel plants are leased and operated by the steel plants. Some installations are practically automatic.

Nitrogen, once a waste product from the manufacture of oxygen, has been recognized as a useful product. In addition to its use in chemical manufacturing (such as the plant at Geneva Steel Works, as discussed last year), plans are now under way to use it in producing atmosphere gas for annealing. The project calls for mixing the nitrogen from an oxygen plant with hydrogen obtained from reforming natural gas. The mixture will be used in a large sheet and tinplate mill.

United States Steel Corp. has an extensive oxygen program. One of the biggest on-site oxygen plants will furnish oxygen for four U. S. Steel plants near Pittsburgh: Homestead, Duquesne, Edgar Thomson and National Tube. The oxygen plant will be a 1000-ton-per-day unit of high purity oxygen, and will be owned and operated by the oxygen supplier. Oxygen will be distributed by pipeline to the plants. Provision has been made for future extension of the pipeline to a fifth plant. Estimated cost is around $15,000,000.

A new oxygen plant with a capacity of about 22,000,000 cu ft of oxygen per month also went into operation in the fall at the Clairton Works.

Another new oxygen plant started operation at U. S. Steel's Gary Works. This plant will be built, maintained and operated by the supplier company. It will produce 94,000,000 cu ft per month of high purity oxygen and is designed for automatic, unattended operation. Through a unique control system, the plant will automatically produce oxygen at the rate required by plant operation and pump oxygen into storage tanks for standby and peak requirements. An electronic monitoring system reports continuously to a central office. A similar plant has been installed at U. S. Steel's South Works.

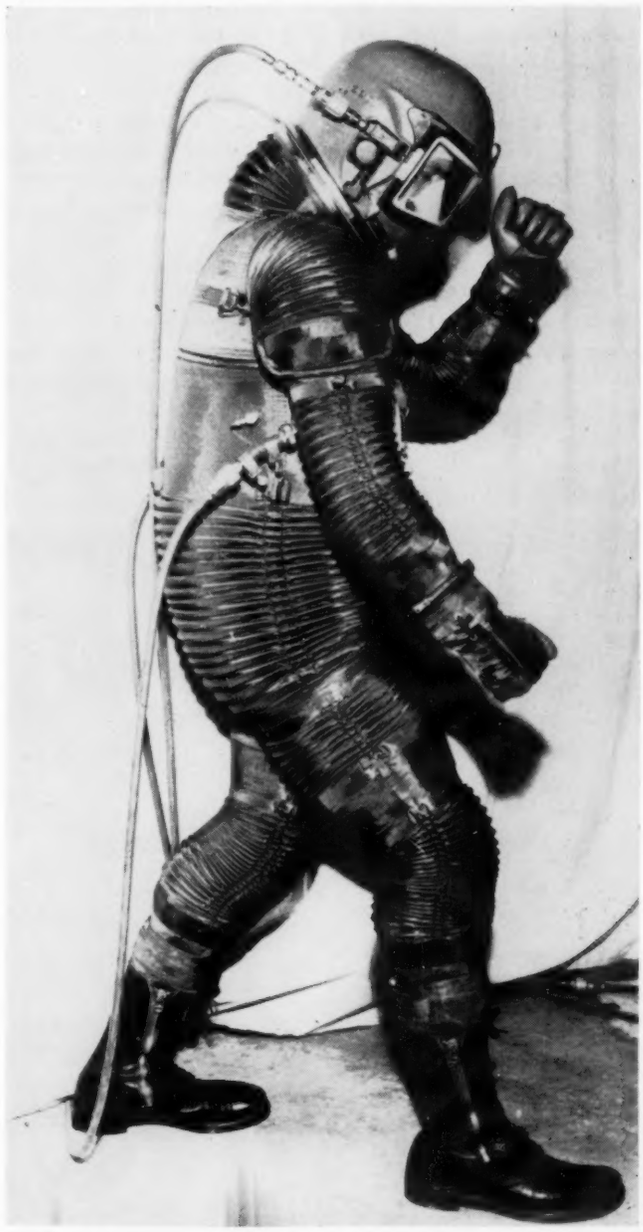
Under construction at Lukens Steel Co. is an automatically operated on-site plant capable of producing high-purity gaseous oxygen at a rate of at least 80,000,000 cu ft per month. This unit is scheduled to go on-stream in January, 1959 and will replace a 20,000,000-cu ft plant. The oxygen plant builder will operate and maintain the plant when it goes into production. Although the plant is designed for unattended operation, a plant superintendent will be permanently assigned to the unit to make regular inspections and oversee maintenance.

A new oxygen-producing plant was installed at Pittsburgh Steel Co.'s Monessen Works, capable of supplying 140 tons of high and low purity oxygen per day. The plant is located on property leased from Pittsburgh Steel and will be owned and operated by the oxygen supplier. The plant will produce about 126 tons of 95 per cent purity oxygen daily which will be used in the open hearth furnaces. In addition, some 14 tons of 99.5 per cent oxygen will be available for cutting and similar operations.

Armco Steel Corp. installed a 115-ton per day oxygen plant at their Ashland Works. A similar plant is being built for Armco's Middletown Works.

Detroit Steel Corp. also made an agreement during the year with a supplier who will build an automatically-operated oxygen plant at Portsmouth, Ohio, with a capacity of 20,000,000 cu ft of 99.5 per cent oxygen per month.

Some alloys must be processed in inert atmospheres and unusual clothing will be required on some operators. Equipment here will be needed by personnel in part of the new Universal Cyclops Steel Corp. plant.



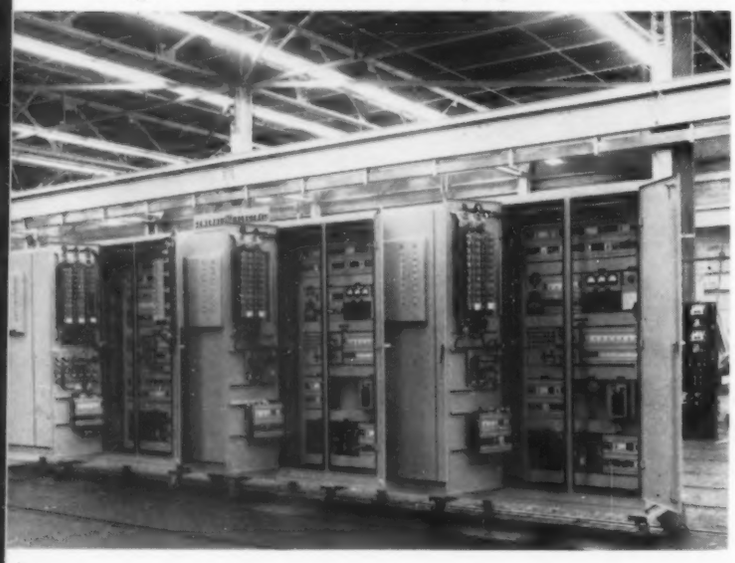
A 60,000,000-cu ft per month oxygen plant was brought into production by Granite City Steel Co. to feed their open hearths. Phoenix Iron & Steel Co., at Phoenixville, Pa., started up a 7,500,000-cu ft per month high purity plant. Also, a plant is under construction to furnish oxygen for the top-blown oxygen converters being installed at Acme Steel Co. in Chicago.

ELECTRICAL

According to some scientists, digital computers will control many steel plant processes within the next five years. Some possible applications in steel plants would be:

1. Production scheduling which will insure that materials are available and add economies in usage.
2. In coke plants computers would be used to blend coals for charging and to monitor production rates of ovens by controlling such variables as air flow.
3. In by-product plants, the computers could control the most critical parts of the operation to increase production.
4. In blast furnaces, computers could proportion iron ore, coke, scrap and limestone, control cooling water rates, charging rates and blowing rates to maintain furnace conditions at their theoretical best.
5. In open hearths, computers could figure the best proportions of pig iron, scrap and sinter for a given melt, control air flow and draft, regulate reversing, and supply data which will determine when to end the heat and also establish the amount of alloy additions which must be added.
6. In soaking pits, computers could bring about savings in fuel consumption by better scheduling of ingots in and out of pits, and they could also be used to control the rate of temperature changes to bring ingots up to heat at the proper time without damaging the ingots or wasting fuel.
7. In rolling mills, the computers could determine how large a bite could be taken on a slab to reduce it in the smallest number of passes, while protecting rolls and leaving the slab on the right side of the mill after the final pass. Such studies have already been taken for a mill in the Chicago district. One problem, however, which is yet to be solved in a study of this type is that although the computer may determine the minimum number of passes, this does not necessarily mean that the proper metallurgical properties follow.

This typical control panel lineup is used on a reversing rougher mill with an automatic program control system.



In most of the present applications, the computers receive data from punch cards and tape which give results in visual form. However, the digital systems of the future will receive their input information directly from processing instruments and, in addition to printing the results, will feed back to controls optimum settings on the flow of materials and other operating variables.

The new digital computers are being designed specifically for the tough service conditions encountered in heavy industry. All circuits in the new lines are completely transistorized; no vacuum tubes are used. All circuits are mounted on printed wiring boards which plug into main equipment racks and are easily removed for servicing and maintenance.

Computer systems now available for steel plant applications include tin plate data accumulating systems, gage logging systems, data acquisition systems for sintering plants and static card readers for rolling mill control.

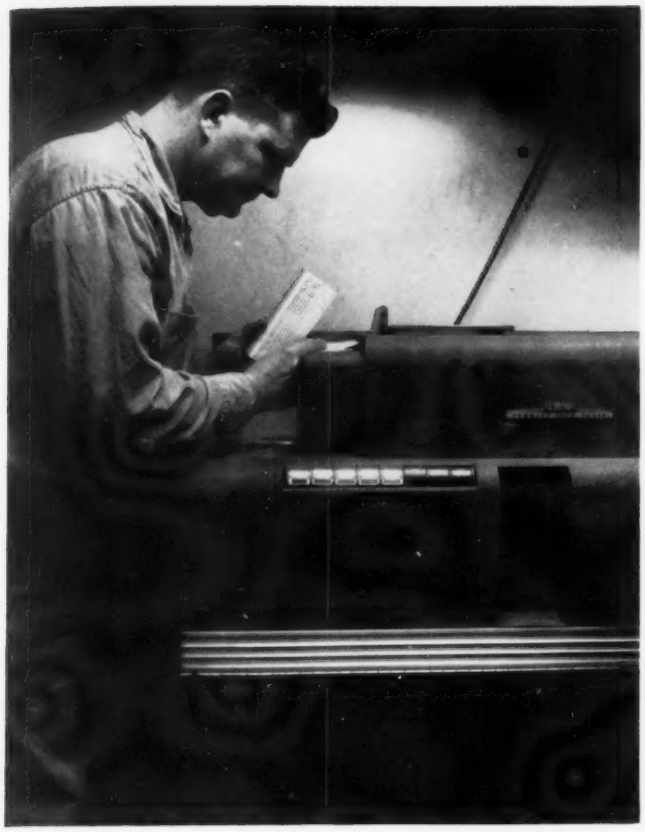
The tin plate data accumulator integrates data from various automatic inspection devices on the electrolytic tinning line. It provides a record of the total number of feet of prime material in a coil of tin plate, as well as a record of the number of feet affected by each defect such as pinholes, thin material or light coating. The rapid response of such systems enables them to provide an accurate record of all data which could not be obtained through human operation because of the high speed at which the line operates. Typewritten copy, punch card or punch tape records may be provided.

Gage logging equipment is designed to work in conjunction with X-ray thickness gages to provide a record of the total number of feet of on-gage material and the total number of feet of off-gage material lying in each tolerance band on both the over and under sides of tolerance. It is used for mill evaluation and operator evaluation and determining quality of the product produced.

Under design is a large data processing system for sintering plants. The system will gather and record data from numerous points as required, convert the data into engineering units and print out a typewritten record. It will be used to study operation of sintering plants for improving plant performance. Points are continuously monitored, and where measured values exceed predetermined tolerances, provisions are made to actuate an alarm. The system can probably be expanded to provide direct computer control of sintering plant operation.

An improved version of an automatic program control system illustrates the trends. This unit incorporates a static photoelectric card reader, a small unit measuring 15 in. in height, 20 in. wide and 24 in. deep. The elimination of contact-making brushes in the card reader make it ideal for rugged industrial service.

Information is punched into the cards in a binary decimal code. The control panels are composed of individual modules, each of which represents a functional portion of the controls. These modules are composed of a series of small plug-in units so designed that



The card reader is an important element in program control.

they can be removed readily for testing or replacement. Built-in test circuits are provided for ease of maintenance. Redundancy and validity tests are also built into the system to recognize and indicate an improperly punched card.

Under construction this year is the nation's first steam turbine-driven generator with water-cooled stator windings. This is a 450,000-kw unit being built for a large utility. A similar unit with oil-cooled stators is being installed at another utility. Water cooling may make it possible to double generator ratings in the same frame size.

The new 10,000-hp reversing plate mill being installed by Lukens Steel Co. features a sealed ignitron rectifier reversing drive. The rectifier was chosen for this plate mill because investment cost showed a small advantage over the motor-generator set. When power costs were added on the basis of the mill duty cycle, appreciable additional savings were indicated.

The rectifier chosen for this mill is rated 8000 kw at 750 volts. It is capable of 225 per cent load on an "every ingot" basis and a 275 per cent load occasionally. Primary power is supplied at 13.8 kv. The main mill drive is a 10,000-hp, 40/80-rpm, 750-volt twin drive consisting of two 5000-hp motors. A 3000-hp, 70/175-rpm edger motor is used.

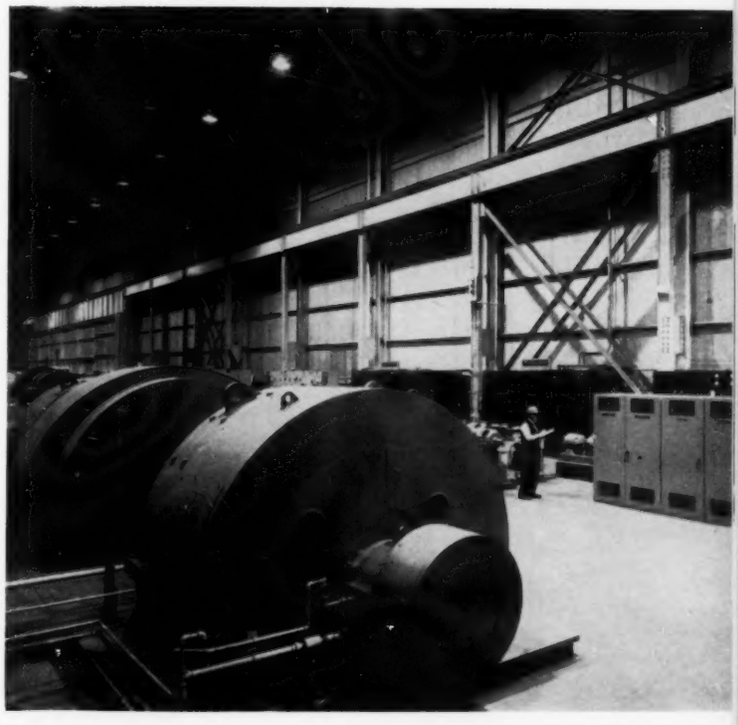
The construction of a complete recirculating ventilating system as part of the motor base, with necessary blowers, filters and heat exchangers, permitted location of the motors directly in the mill area outside the motor room.

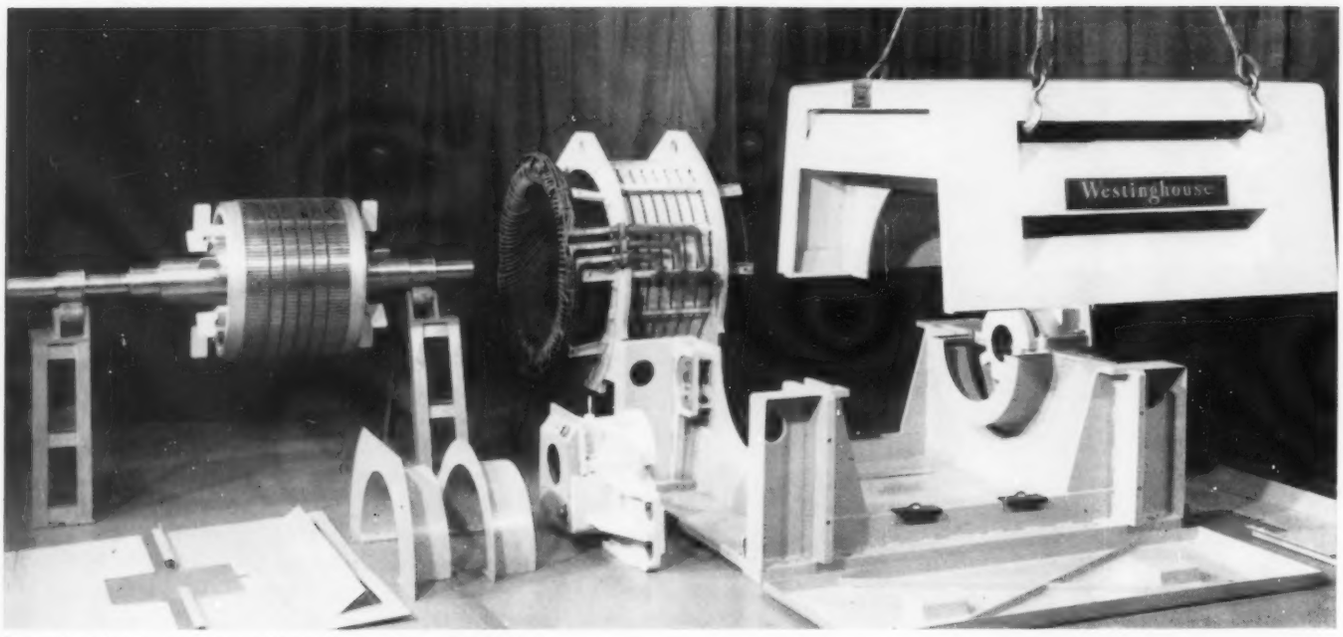
An interesting rectifier application is the use of back-to-back rectifiers on power shear drives on a combination merchant bar and rod mill. The system will control and drive a crop and cobble shear as well as a rotary drum dividing shear. Both shears must cut the product while it is moving at speeds up to 904 fpm on the crop and cobble shear and up to 3000 fpm on the rotary shear. Time cycle for the cut is about $\frac{1}{4}$ second at top speed. Rectifiers were chosen because of their ability to provide a high current quickly. The rectifier for the crop and cobble shear converts power supply for a 200-hp, 500-volt d-c motor, while the rectifier for the rotary drum shear supplies power for a 100-hp, 230-volt d-c motor.

A new water-cooled silicon rectifier has been designed providing either regulated or unregulated d-c power for continuous processing lines. The rectifier uses a saturable reactor-magnetic amplifier control to maintain the desired current level within plus or minus one per cent, with unit efficiencies running 90 to 95 per cent depending on the voltage rating of the equipment. They are available in ratings of 1000 to 10,000 amperes at voltages up to 300. An outstanding feature is the short circuit limiting capability of the saturable reactor which successfully restricts short circuit current to a value about 20 per cent greater than the current prior to the short circuit. The rectifier is designed to withstand such output without damage to components. Use of water-cooled bus bar completely eliminates the need for rings and gaskets and makes it possible to change cells without draining the system. To provide for rapid fault isolation and simplified maintenance, the panel is equipped with indicating lights and an alarm bell which indicate various abnormal conditions.

Jones & Laughlin Steel Corp. modernized some 25-year old drive motors for their hot strip mill at Cleveland. All the drive motors on the plant's six-stand, 77-in. hot strip mill were revamped. Top speed was increased from 400 to 450 rpm.

Electrical equipment for J&L's new hot strip reversing mill rougher at the Aliquippa plant.





Standardized components feature new motor line.

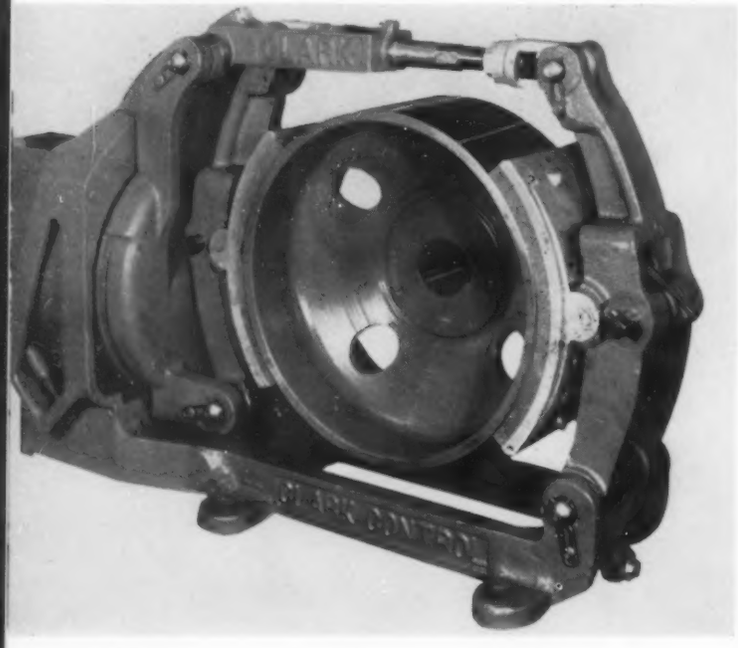
A number of features are incorporated in the new hot mill line at Kaiser Aluminum's Ravenswood Works. Through television cameras, operators have an unobstructed view as the ingots proceed through the mill.

The installation includes several firsts for aluminum plants, such as an individual stand power supply system, and adjustable voltage d-c drives on the screwdowns.

A new line of hollow shaft floating motors saves space and reduces maintenance for runout table application. Variable speed motors rated at 75 C rise continuous are available in a range from 1 through 10 hp.

The hollow shaft motors fit right over the table roller shaft, eliminating the need for special flexible couplings. A heavy tie-down spring assembly flexes to compensate for roller warpage and backlash. The motors have a unique plug-in feature in which the conduit connection actually plugs into the fuse box mounted below the motors.

New brake was designed to meet revised AISE brake specifications.



A new concept in the design of large a-c motors is available in a new, fully accessible motor design. This design permits the enclosure to be manufactured independent of the wound stator. During assembly, the enclosure is merely bolted to the base of the motor, making the wound stator fully accessible when required. This entire line of squirrel-cage, wound-rotor and synchronous motors, from 250 to 7000 hp, has been redesigned to use only six basic enclosures and 30 frame sizes compared to the 450 frame sizes formerly used.

Another new line of motors results from a complete redesign during the past four years, based upon a thorough review of modern mill drive requirements. The motor is in accordance with NEMA standards with both 40 and 50 C ratings. It is forced ventilated and furnished with class B insulation throughout. Quick removal covers provide enclosure on both ends. Constant pressure brush holders, standard for both nonreversing and reversing motors, maintain correct brush pressure at all times, regardless of brush wear. Integral ventilation is available as a standard modification.

New brush holders, designed to provide constant pressure and uniformity of wear of brushes in both a-c and d-c motors and generators have a holder consisting of a one-piece die casting and coiled spring, eliminating the need of periodic adjustment of brushes by maintenance personnel. For d-c equipment, the holder has an inspection window for determining when the brush has reached the end of its useful life.

A number of innovations are features in a new design of circuit breakers and switchgear. Among the units is a molded cage circuit breaker which provides continuous current ratings of 400 amperes in two-thirds the space formerly required. The new design is available in two or three pole models, providing interrupting ratings up to 25,000 amperes at 600 volts alternating current.

Another design involves a metal-enclosed 6-pole anode circuit breaker arranged to permit drawout of individual poles without interruption of process power.

One of the most advanced hot strip mill control systems is that installed at the Geneva Works of Columbia-Geneva Steel Division of the United States Steel Corp. This system is designed to take into account the pressure variations because of temperature variation in the slab which affects final gage. On this mill six finishing stands have been equipped with pressure gages designed and built in Sweden for U. S. Steel. The electrical impulses from the pressure gages actuate the electrical control system, which changes both the pressure and the speed of the mills to give a more uniform product.

An innovation in motor and control systems design is a packaged motor and control room, giving reduced installation and maintenance cost. These rooms will house entire systems in ventilated dust-free enclosures. The basic size is approximately 8 ft high, up to 10 ft deep and up to 20 ft long. Two or more of the units can be placed together in modular fashion to accommodate control systems of virtually any size, and in some cases, the necessity for a separate motor room can be eliminated.

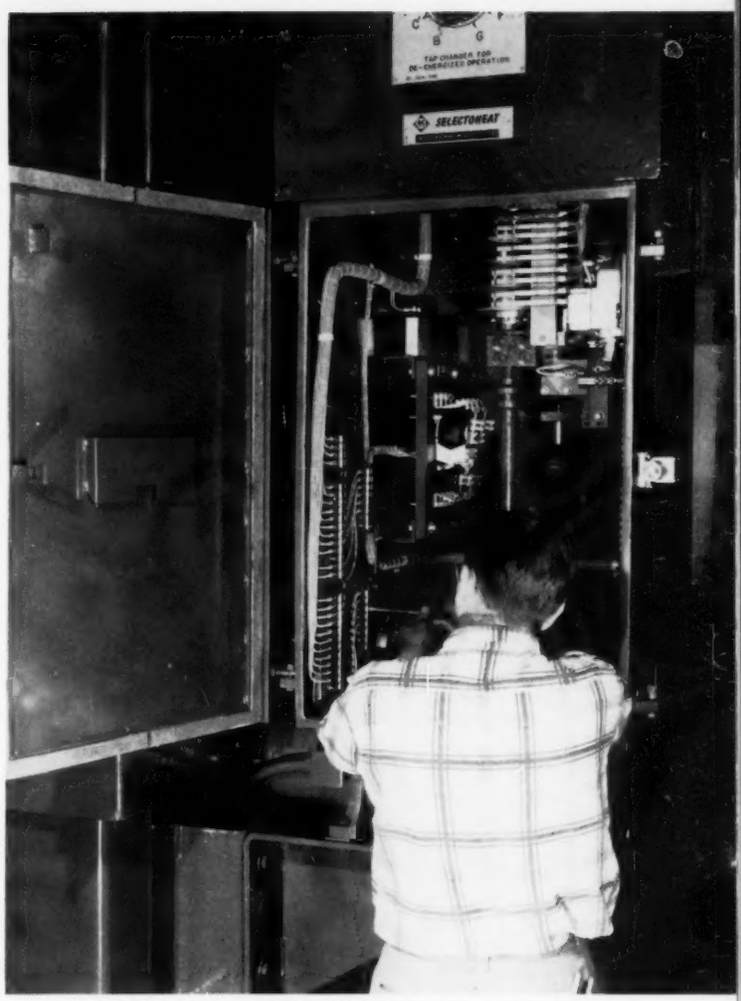
The complete package includes a-c and d-c control, motor-generator sets, motor-operated rheostats, associated control equipment, interior lighting and ventilation equipment.

A new line of stepless a-c reactor crane controls was developed during the year. The circuitry employs static magnetic components. The control includes both static-reversing and contactor-reversing reactor controls. The unique circuit employs saturable transformers and reactors to reverse the motor statically without the use of reversing contactors. This control provides stepless speed regulation without the use of either a mechanical or electrical load brake. The regulated speed is associated with each position of the master switch and insures accurate, precise spotting of all loads under all conditions.

A new stepless master switch with thumb-latch attachment enables the operator to obtain creeping speeds in both directions or even bring the load to a standstill without setting the holding brake and removing power from the motor.

An alternate design is a contact reversing control. The saturable reactors are used in the secondary windings of a wound-rotor motor to provide accurate speed control. Reversing is accomplished by means of conventional contactors. Although primarily designed for reversing-plugging operations on traverse motions, the contactor-reversing drive can also be applied to hoists which are equipped with either mechanical or eddy-current load brakes. It can be used with single, duplex or quadruplex motor applications on overhead traveling cranes. In both types of control, the secondary contactors normally associated with wound-rotor motor control are completely eliminated. The use of static-magnetic devices in the control circuits instead of either relays or electronic tubes is another feature which contributes to reliability and minimum maintenance.

Another new crane and hoist drive was introduced during the year. This is a constant horsepower drive offering a wide speed range under all operating conditions. It adjusts speeds automatically according to the amount of weight on the lift hook.



Electric furnace operation will be aided by a new type tap changer control for transformers.

The drive is designed for operation on all standard-voltage, three-phase a-c power supplies. The system consists of an operator's station, a variable speed control unit and a special shunt-wound variable speed motor equipped with a holding brake. The operator's station has a joy stick controller. The motion of the stick adjusts the voltage output of the control generator and the strength of the motor field through a magnetic amplifier. The first two speed settings give consistent accurate slow speeds regardless of the amount of weight on the lift hook. At the higher three positions of the controller, the regulator system controls the motor excitation, providing the highest speed possible in relation to the load being carried. The operator has no adjustment to make other than move the joy stick to and fro. This drive requires no secondary resistors or large accelerating and main line contactors.

The drive system is equipped with regenerative braking to take care of overhauling load conditions. If the a-c power supply in the electrically-operated holding brake is cut off, electrical interlocks automatically cause the lift hook and its load to lower slowly under controlled dynamic braking.

ELECTRIC MOTOR DRIVES THREE HUNDRED HORSEPOWER AND OVER

APPLIED TO ROLLING MILLS IN THE IRON AND STEEL AND ALLIED INDUSTRIES DURING 1958

Item	Horsepower	Revolutions per minute	Volts	Frequency	Method of drive	Type of mill	Purchaser	Location	Manufacturer
1	350	300/900	700	d-c	Geared	14-Stand merchant bar mill, stand 13	Lemont Mfg. Corp.	Lemont, Ill.	Westinghouse
2	350	850/1200	600	d-c	Direct	2-High temper mill tension device	U. S. Steel Corp.	Gary, Ind.	Westinghouse
3	350	850/1200	600	d-c	Direct	2-High temper mill tension device	U. S. Steel Corp.	Gary, Ind.	Westinghouse
4(2)	350	500/1250	600	d-c	Geared	Unwinding reel	Mirro Mfg. Co.	Manitowac, Wis.	Elliott
5	400	450/1250	600	d-c	Geared	13-In. Sendzimir reel	Athenia Steel Div., National-Standard Co.	Clifton, N. J.	General Electric
6	400	450/1250	600	d-c	Geared	13-In. Sendzimir reel	Athenia Steel Div., National-Standard Co.	Clifton, N. J.	General Electric
7	400	500/1000	250	d-c	Geared	20-In. intermediate mill	Western Electric Co., Inc.	Chicago, Ill.	General Electric
8	400	500/1250	600	d-c	Geared	43-In. single stand foil mill	Alumino Industrial Mexicano	Mexico City, Mexico	General Electric
9	400	400/1200	700	d-c	Geared	14-Stand merchant bar mill, stand 11	Lemont Mfg. Corp.	Lemont, Ill.	Westinghouse
10	400	400/1200	700	d-c	Geared	14-Stand merchant bar mill, stand 12	Lemont Mfg. Corp.	Lemont, Ill.	Westinghouse
11	400	690/875	250	d-c	Direct	Temper mill	U. S. Steel Corp.	Gary, Ind.	Reliance
12	500	300/900	700	d-c	Geared	14-Stand merchant bar mill, stand 14	Lemont Mfg. Corp.	Lemont, Ill.	Westinghouse
13(2)	500	500/1250	600	d-c	Geared	Winding reel	Mirro Mfg. Co.	Manitowac, Wis.	Elliott
14	500	690/1150	600	d-c	Geared	13-In. Sendzimir mill main drive	Athenia Steel Div., National-Standard Co.	Clifton, N. J.	General Electric
15	500	340	230	d-c	Geared	Hot slab shear	Reynolds Metals Co.	Listerhill, Ala.	General Electric
16	500	340	230	d-c	Geared	Hot slab shear	Reynolds Metals Co.	Listerhill, Ala.	General Electric
17†	600	720	4,160	60	Geared	Five-stand bar mill main drive	Western Electric Co., Inc.	Chicago, Ill.	General Electric
18	600	400/800	600	d-c	Direct	4-High aluminum foil mill	Mirro Mfg. Co.	Manitowac, Wis.	Reliance
19	700	350/875	700	d-c	Geared	Rod and merchant mill, stands 1 & 2	Planta Siderurgica del Orinoco	Puerto Ordaz, Venezuela	Westinghouse
20	700	350/875	700	d-c	Geared	Rod and merchant mill, stands 3 & 4	Planta Siderurgica del Orinoco	Puerto Ordaz, Venezuela	Westinghouse
21	700	350/875	700	d-c	Geared	Rod and merchant mill, stand 7	Planta Siderurgica del Orinoco	Puerto Ordaz, Venezuela	Westinghouse
22	700	350/875	700	d-c	Geared	Rod and merchant mill, stand 8	Planta Siderurgica del Orinoco	Puerto Ordaz, Venezuela	Westinghouse
23	700	350/875	700	d-c	Geared	Rod and merchant mill, stand 9	Planta Siderurgica del Orinoco	Puerto Ordaz, Venezuela	Westinghouse
24	700	350/875	700	d-c	Geared	Rod and merchant mill, stand 10	Planta Siderurgica del Orinoco	Puerto Ordaz, Venezuela	Westinghouse
25	700	350/875	700	d-c	Geared	Rod and merchant mill, stand 11	Planta Siderurgica del Orinoco	Puerto Ordaz, Venezuela	Westinghouse
26	700	350/875	700	d-c	Geared	Rod and merchant mill, stand 12	Planta Siderurgica del Orinoco	Puerto Ordaz, Venezuela	Westinghouse
27	700	450/760	600	d-c	Direct	Sendzimir mill main drive	Superior Steel Div., Copperweld Steel Co.	Carnegie, Pa.	Westinghouse
28	700	350/1050	600	d-c	Geared	Sendzimir mill reel	Superior Steel Div., Copperweld Steel Co.	Carnegie, Pa.	Westinghouse
29	700	350/1050	600	d-c	Geared	Sendzimir mill reel	Superior Steel Div., Copperweld Steel Co.	Carnegie, Pa.	Westinghouse
30	750	100/300	700	d-c	Geared	72-In. reversing plate mill edger revamp	Companhia Siderurgica Nacional	Volta Redonda, Brazil	Westinghouse
31	750	350/750	600	d-c	Geared	18-In. breakdown mill	Western Electric Co., Inc.	Chicago, Ill.	General Electric
32	750	350/750	600	d-c	Geared	18-In. blooming mill	Western Electric Co., Inc.	Chicago, Ill.	General Electric
33	800	350/875	700	d-c	Geared	Rod and merchant mill, stand 13	Planta Siderurgica del Orinoco	Puerto Ordaz, Venezuela	Westinghouse
34	800	350/875	700	d-c	Geared	Rod and merchant mill, stand 14	Planta Siderurgica del Orinoco	Puerto Ordaz, Venezuela	Westinghouse
35	800	350/875	700	d-c	Geared	Rod and merchant mill, stand 15	Planta Siderurgica del Orinoco	Puerto Ordaz, Venezuela	Westinghouse
36	800	350/875	700	d-c	Geared	Rod and merchant mill, stand 16	Planta Siderurgica del Orinoco	Puerto Ordaz, Venezuela	Westinghouse
37	800	575/1150	600	d-c	Direct	Metal rolling mill	Hunter Engineering Co.	Riverside, Calif.	Reliance
38	900	250/625	700	d-c	Geared	14-Stand merchant bar mill, stands 9 & 10	Lemont Mfg. Corp.	Lemont, Ill.	Westinghouse
39	900	225/507	600	d-c	Direct	Cold mill reel	Weirton Steel Co., Div. National Steel Corp.	Weirton, W. Va.	Westinghouse
40(2)	1000	250/870	600	d-c	Geared	120-In. hot strip mill reel	Reynolds Metals Co.	Listerhill, Ala.	Westinghouse
41(2)	1000	175/660	750	d-c	Direct	56-In. three stand tandem cold strip mill reel	Companhia Siderurgica Nacional	Volta Redonda, Brazil	General Electric
42(4)	1000	500/990	700	d-c	Geared	Stretch reducing mill	National Tube Div., U. S. Steel Corp.	Lorain, Ohio	General Electric
43*	1000	514	2,300	60	Geared	79-In. hot strip mill edger	Youngstown Sheet and Tube Co.	Youngstown, Ohio	General Electric
44(2)	1000	250/870	600	d-c	Geared	120-In. hot strip mill reel	Reynolds Metals Co.	Listerhill, Ala.	Westinghouse
45	1000	350/875	700	d-c	Geared	Rod and merchant mill, stands 5 & 6	Planta Siderurgica del Orinoco	Puerto Ordaz, Venezuela	Westinghouse
46*	1000	400	4,160	60	Geared	14-Stand merchant bar mill, stand 1	Lemont Mfg. Corp.	Lemont, Ill.	Westinghouse
47*	1000	400	4,160	60	Geared	14-Stand merchant bar mill, stands 2, 3, & 4	Lemont Mfg. Corp.	Lemont, Ill.	Westinghouse
48*	1250	900	4,160	60	Geared	Enlarge bar mill	Calumet Steel Div., Borg-Warner Corp.	Chicago Heights, Ill.	Westinghouse
49	1250	250/775	600	d-c	Geared	Reversing cold mill reel	Empire-Reeves Corp.	Mansfield, Ohio	Westinghouse
50	1250	250/775	600	d-c	Geared	Reversing cold mill reel	Empire-Reeves Corp.	Mansfield, Ohio	Westinghouse
51	1250	300/788	600	d-c	Geared	20 x 42 x 66-in., 4-high reversing mill	Union Carbide Nuclear Co.	Oak Ridge, Tenn.	Elliott
52*	1250	1200	2,300	60	Geared	12 x 24 x 24-in., 4-high non-reversing mill	Waterbury Rolling Mills	Waterbury, Conn.	Elliott
53*	1250	600	2,300	60	Geared	4-High non-reversing hot mill	Reynolds Metals Co.	Louisville, Ky.	Elliott
54	1500	250/700	600	d-c	Geared	15 x 44 x 60-in., 4-high reversing mill	Mirro Mfg. Co.	Manitowac, Wis.	Elliott
55(3)	1500	300/1380	750	d-c	Direct	48-In., 5-stand tandem cold mill reel	Rasselstein (August Thyssen-Huette, A.G.)	Andernach, Germany	General Electric
56	1500	300/650	700	d-c	Geared	Rod and merchant mill, stands 17 through 22	Planta Siderurgica del Orinoco	Puerto Ordaz, Venezuela	Westinghouse
57*	1500	300	4,160	60	Geared	14-Stand merchant bar mill, stands 5, 6, 7 & 8	Lemont Mfg. Corp.	Lemont, Ill.	Westinghouse
58	1500	125/250	600	d-c	Direct	No. 3 stand cold mill	Weirton Steel Co., Div. of National Steel Corp.	Weirton, W. Va.	Westinghouse
59	1500	150/300	600	d-c	Direct	No. 4 stand cold mill	Weirton Steel Co., Div. of National Steel Corp.	Weirton, W. Va.	Westinghouse
60	1750	60/180	700	d-c	Direct	22-In. billet mill	Altos Hornos de Mexico, S. A.	Montclova Coahuila, Mexico	General Electric
61*	1750	900	4,160	60	Geared	Enlarge bar mill	Calumet Steel Div., Borg-Warner Corp.	Chicago Heights, Ill.	Westinghouse
62	2000	250/465	240	d-c	Geared	Piercer mill	Timken Roller Bearing Co.	Canton, Ohio	Westinghouse
63(1)	2000	200/500	600	d-c	Direct	60-in. reversing cold mill	Dominion Foundries & Steel, Ltd.	Hamilton, Ont.	General Electric
64(1)	2000	200/500	600	d-c	Direct	60-In. reversing cold mill	Dominion Foundries & Steel, Ltd.	Hamilton, Ont.	General Electric
65(7)	2000	175/300	600	d-c	Geared	79-In. hot strip mill, finishing stand No. 5	Youngstown Sheet and Tube Co.	Youngstown, Ohio	Westinghouse
66(7)	2000	175/350	600	d-c	Geared	79-In. hot strip mill, finishing stand No. 6	Youngstown Sheet and Tube Co.	Youngstown, Ohio	Westinghouse
67(7)	2000	175/350	600	d-c	Geared	79-In. hot strip mill, finishing stand No. 7	Youngstown Sheet and Tube Co.	Youngstown, Ohio	Westinghouse
68(7)	2000	175/350	600	d-c	Geared	79-In. hot strip mill, finishing stand No. 8	Youngstown Sheet and Tube Co.	Youngstown, Ohio	Westinghouse
69(7)	2000	175/350	600	d-c	Geared	79-In. hot strip mill, finishing stand No 9	Youngstown Sheet and Tube Co.	Youngstown, Ohio	Westinghouse
70(7)	2000	175/350	600	d-c	Direct	79-In. hot strip mill, finishing stand No. 10	Youngstown Sheet and Tube Co.	Youngstown, Ohio	Westinghouse
71	2500	30/60	600	d-c	Direct	32 x 72-in. reversing hot strip mill	Mirro Mfg. Co.	Manitowac, Wis.	Elliott
72(1)	2500	40/80	700	d-c	Direct	40-In. blooming mill main drive	Babcock & Wilcox Co.	Beaver Falls, Pa.	General Electric
73(1)	2500	40/80	700	d-c	Direct	40-In. blooming mill main drive	Babcock & Wilcox Co.	Beaver Falls, Pa.	General Electric
74	2500	90/270	750	d-c	Direct	56-In., three-stand, tandem cold strip mill, stand 1	Companhia Siderurgica Nacional	Volta Redonda, Brazil	General Electric

ELECTRIC MOTOR DRIVES THREE HUNDRED HORSEPOWER AND OVER

(Continued)

Item	Horsepower	Revolutions per minute	Volts	Frequency	Methods of drive	Type of mill	Purchaser	Location	Manufacturer
75	2500	90/270	750	d-c	Direct	48-In., five-stand tandem cold strip mill, stand 1	Rasselstein (August Thyssen-Huette, A.G.)	Andernach, Germany	General Electric
76①	2500	150/370	700	d-c	Geared	120-In. hot strip mill, stand 2	Reynolds Metals Co.	Listerhill, Ala.	Westinghouse
77①	2500	150/370	700	d-c	Geared	120-In. hot strip mill, stand 2	Reynolds Metals Co.	Listerhill, Ala.	Westinghouse
78①	2500	150/370	700	d-c	Geared	120-In. hot strip mill, stand 3	Reynolds Metals Co.	Listerhill, Ala.	Westinghouse
79①	2500	150/370	700	d-c	Geared	120-In. hot strip mill, stand 3	Reynolds Metals Co.	Listerhill, Ala.	Westinghouse
80	3000	125/375	600	d-c	Direct	Reversing cold mill	Empire-Reeves Corp.	Mansfield, Ohio	Westinghouse
81①②	3000	400/800	750	d-c	Geared	48-In., five-stand tandem cold strip mill, stand 5	Rasselstein (August Thyssen-Huette, A.G.)	Andernach, Germany	General Electric
82①②	3000	400/800	750	d-c	Geared	48-In., five-stand tandem cold strip mill, stand 5	Rasselstein (August Thyssen-Huette, A.G.)	Andernach, Germany	General Electric
83	3000	50/100	750	d-c	Direct	2-High reversing breakdown mill	Algoma Steel Corp., Ltd.	Sault Ste. Marie, Ont.	General Electric
84②	4000	150/375	750	d-c	Direct	56-In., three-stand tandem cold strip mill, stand 2	Companhia Siderurgica Nacional	Volta Redonda, Brazil	General Electric
85②	4000	200/475	750	d-c	Direct	56-In., 3-stand tandem cold strip, stand 3	Companhia Siderurgica Nacional	Volta Redonda, Brazil	General Electric
86②	4500	150/350	750	d-c	Direct	48-In., 5-stand tandem cold strip mill, stand 2	Rasselstein (August Thyssen-Huette, A.G.)	Andernach, Germany	General Electric
87②	4500	225/510	750	d-c	Direct	48-In., 5-stand tandem cold strip mill, stand 3	Rasselstein (August Thyssen-Huette, A.G.)	Andernach, Germany	General Electric
88	4500	86/172	750	d-c	Direct	66-In., 3-stand combination hot strip mill, stand 4	Dominion Foundries & Steel, Ltd.	Hamilton, Ont.	General Electric
89	4500	114.5/229	750	d-c	Direct	66-In., 3-stand combination hot stripmill, stand 5	Dominion Foundries & Steel, Ltd.	Hamilton, Ont.	General Electric
90	4500	140/280	750	d-c	Direct	66-In., 3-stand combination hot stripmill, stand 6	Dominion Foundries & Steel, Ltd.	Hamilton, Ont.	General Electric
91②	5000	150/370	700	d-c	Geared	120-In. hot strip mill, stand 1	Reynolds Metals Co.	Listerhill, Ala.	Westinghouse
92②	5000	150/370	700	d-c	Geared	120-In. hot strip mill, stand 4	Reynolds Metals Co.	Listerhill, Ala.	Westinghouse
93*	5000	375	6,600	50	Geared	72-In. plate roughing mill stand	Companhia Siderurgica Nacional	Volta Redonda, Brazil	General Electric
94③	5000	350/700	750	d-c	Direct	48-In., 5-stand tandem cold strip mill, stand 4	Rasselstein (August Thyssen-Huette, A.G.)	Andernach Germany	General Electric
95*	6000	240	13,200	60	Geared	79-In. hot strip universal mill, stand 1	Youngstown Sheet and Tube Co.	Youngstown, Ohio	General Electric
96*	6000	300	13,200	60	Geared	79-In. hot strip universal mill, stand 2	Youngstown Sheet and Tube Co.	Youngstown, Ohio	General Electric
97*	6000	300	13,200	60	Geared	79-In. hot strip universal mill, stand 3	Youngstown Sheet and Tube Co.	Youngstown, Ohio	General Electric

* Indicates synchronous motor. ① Indicates twin motor drive. ③ Indicates triple armature.
† Indicates induction motor. ② Indicates double armature. ④ One-half double armature. ⑦ Present motor used for portion of tandem armature.

MOTOR RECAPITULATION

Company	Location	Type of mill	Number of motors	Total horsepower
Algoma Steel Corp. Ltd.	Sault Ste. Marie, Ont.	2-High reversing breakdown mill	1	3,000
Altos Hornos de Mexico, S. A.	Montclova, Coahuila, Mexico	22-In. billet mill	1	1,750
Alumino Industrial Mexicano	Mexico City, Mexico	43-In. single stand foil mill	1	400
Athenia Steel Div., National Standard Co.	Clifton, N. J.	13-In. Sendzimir mill	3	1,300
Babcock & Wilcox Co.	Beaver Falls, Pa.	40-In. blooming mill	2	5,000
Calumet Steel Div., Borg-Warner Corp.	Chicago Heights, Ill.	Enlarge bar mill	2	3,000
Companhia Siderurgica Nacional	Volta Redonda, Brazil	72-In. reversing plate mill	2	5,750
		56-In., 3-stand tandem cold strip mill	4	11,500
Dominion Foundries & Steel, Ltd.	Hamilton, Ont.	60-In. reversing cold mill	2	4,000
		66-In., 3-stand combination hot strip mill	3	13,500
Empire-Reeves Corp.	Mansfield, Ohio	Reversing cold mill	3	5,500
Hunter Engineering Co.	Riverside, Calif.	Metal rolling mill	1	800
Lemont Mfg. Corp.	Lemont, Ill.	14-Stand merchant bar mill	8	6,050
Mirro Mfg. Corp.	Manitowac, Wis.	4-High aluminum foil mill	1	600
		32 x 72-in. reversing hot strip mill	1	2,500
		15 x 44 x 60-in., 4-high reversing mill	3	2,350
National Tube Div., United States Steel Corp.	Lorain, Ohio	Stretch reducing mill	1	1,000
Planta Siderurgica del Orinoco	Puerto Ordaz, Venezuela	Rod and merchant mill	14	11,300
Rasselstein (August Thyssen-Huette, A.G.)	Andernach, Germany	48-In., 5-stand tandem cold strip mill	7	24,000
Reynolds Metals Co.	Listerhill, Ala.	120-In. hot strip mill	8	22,000
		Hot slab shear	2	1,000
	Louisville, Ky.	4-High non-reversing hot mill	1	1,250
Superior Steel Div., Copperweld Steel Co.	Carnegie, Pa.	Sendzimir mill	3	2,100
Timken Roller Bearing Co.	Canton, Ohio	Piercer mill	1	2,000
Union Carbide Nuclear Co.	Oak Ridge, Tenn.	20 x 42 x 66-in., 4-high reversing mill	1	1,250
United States Steel Corp.	Gary, Ind.	Two-high temper mill	3	1,100
Waterbury Rolling Mills	Waterbury, Conn.	12 x 24 x 24-in., 4-high nonreversing mill	1	1,250
Weirton Steel Co., Div. of National Steel Corp.	Weirton, W. Va.	Cold mill	3	3,900
Western Electric Co., Inc.	Chicago, Ill.	20-In. intermediate mill	1	400
		5-Stand bar mill	1	600
		18-In. breakdown mill	1	750
		18-In. blooming mill	1	750
Youngstown Sheet and Tube Co.	Youngstown, Ohio	79-In. hot strip universal mill roughing train	4	19,000
		79-In. hot strip mill finishing train	6	12,000

Types of motors purchased	Number of motors	Total horsepower
Alternating-current motors	13	32,100
Direct-current motors	84	140,550
	97	172,650

A new line of d-c motor brakes feature high rigidity, simplicity of adjustment and easy servicing without disturbing torque adjustment. The line includes 10, 13, 16, 19 and 23-in. wheel sizes. This brake line meets the new NEMA-AISE standards for use with AISE 600 series mill-type motors.

The brake utilizes a nut-cracker design, hinged at the top for equal distribution of applied pressure. The unique mounting method holds shoes in spring-loaded sockets without depending on pins to connect them to

the arms. A partial turn of a wrench releases pressure so that the shoes can be slid out of the side without removing the wheel. The brake shoes are self-alining and interchangeable end for end and with each other. All maintenance adjustments can be made from the top of the brake. A single adjustment, with built-in indicator, sets the air gap. The magnet case and coil can be removed and replaced without releasing the brake. Brake wheel and motor armature can be removed from the unit without disturbing torque adjustment.

A new limit switch, operating on the principle of resonant circuit, operates without physical contact. This switch has been designed for heavy mill application where impact and shock can cause mechanical limit switches to break down. The switch consists of three parts: a magnetic vane attached to the moving portion of the machine, a reactor unit mounted on the stationary portion of the machine and a standard a-c relay which opens or closes the circuit. As the magnetic vane passes over the reactor it actuates a relay. High sensitivity permits the switch to function when the vane is within $\frac{7}{8}$ in. of the reactor and operation is not affected by voltage variations up to plus or minus 10 per cent. Because no vacuum tubes are used, the switch can operate in the same high temperatures as a mechanical limit switch.

The new electric furnace at the Duquesne Works of U. S. Steel is equipped with a 25,000-kva, forced-oil, water-cooled transformer. This transformer is equipped with a system which enables the operator to arrange tap sequences at eye level instead of through the top of the tank.

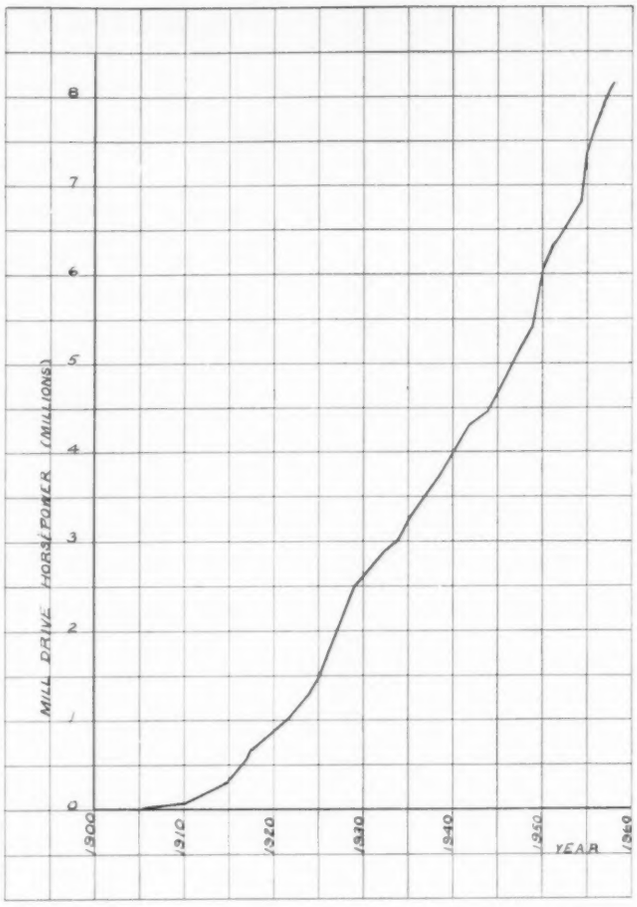
All primary taps are brought to a motor-operated changer in a separate compartment on the side of the transformer tank. The positions on the tap-changer panels are connected to the control board. Here a series of terminals are selected to set up the required heat sequence for furnace operation. When tap sequences are completed, the positions are regulated on the furnace operator's panel.

Ceramic materials were developed which can convert heat directly into electricity without moving parts. Efficiency of the new materials is about two per cent compared with the 30 to 40 per cent efficiency of a steam generator. No immediate commercial application is foreseen. Present application would be where compactness, light weight and simplicity are more important than efficiency.

The new materials are ceramics made up from nickel oxide, manganese oxide and lithium-cobalt oxides. They are called mixed valence compounds of the transition metals.

Another new means of developing electrical energy directly is a fuel cell in which two chemicals, separately stored outside the cell, are fed gradually into the cell where they react to develop electrical energy at special collector plates without passing through the form of heat. Residue from the electrochemical reaction passes out of the cell. Some 70 per cent of all the fuel's original energy is converted into electrical energy. The method develops from 10 to 30 times as much electrical energy per pound as does the conventional battery.

Another new family of solid-state devices called thermistors can serve as tiny contactless thermal



Accumulative curve of main drives over 300 hp shows a total as of January 1, 1959 of 8,153,669 hp. Ninety-seven motors (172,650 hp) were added in 1958 of which 84 were direct current and 13 were alternating current.

switches. They offer possibilities for a practical system for over-temperature protection of motors. The units are particularly applicable to totally enclosed motors. When installed directly on the motor windings, they will operate a small external relay which de-energizes the motor or gives a signal when overheating occurs.

The application rests on the unique ability of thermistors to display an abrupt and substantial increase in resistance when temperatures rise to a specified point and their ability to return to nominal resistance value when cooled below that point or level. By varying the composition of the thermistor during manufacture, it is possible to precontrol its residual resistances and the temperature level at which switching occurs.

The thermistors are now being produced in small ceramic disks, roughly the size of aspirin tablets, which are surfaced on opposite faces with a metallic coating. Before use they are fitted with leads and encapsulated in an epoxy resin having proper thermal, electrical and mechanical characteristics.

Sales of main mill drive motors during the year were down very markedly, and of those sold an appreciable portion was scheduled for foreign plants. The horsepower of main drives sold in 1958 totaled 172,650 from 97 motors, about 58 per cent of the previous year's sales. Of the motors sold, 13 were alternating current and 84 were direct current. The accumulative curve of main drive motors over 300 hp shows a total as of January 1, 1959 of 8,153,669 horsepower. ▲

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Rod Mill in operation. All machinery, equipment and utilities installed by Rust personnel.

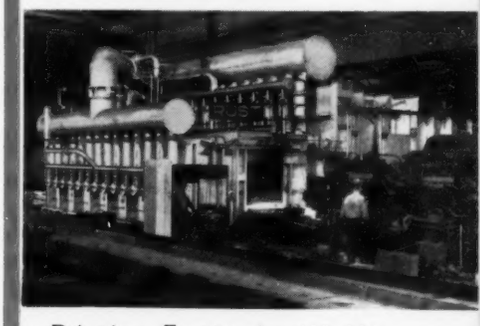
21-Stand, 13" Combination Merchant Bar and Rod Mill Building, designed and constructed for ATLANTIC STEEL COMPANY, Atlanta, Ga.

Helping Atlantic Steel Company fulfill its expansion plans for additional facilities to increase production, The Rust Engineering Company and Subsidiary Companies completed the following contracts, in providing this efficient new mill:

1. **DESIGN AND CONSTRUCTION** Building facilities for this combination merchant bar and rod mill were designed and constructed by The Rust Engineering Company The plant is completely new.
2. **MACHINERY INSTALLATION** All machinery, auxiliary equipment and utilities were installed by The Rust Engineering Company.
3. **ELECTRICAL INSTALLATION** Electrical work was handled by Allegheny Industrial Electrical Company, Inc.
4. **REHEATING FURNACE** The double-fired, zone controlled, recuperative, continuous reheating furnace was designed, built and installed by Rust Furnace Company.

This modern mill has a maximum speed of 5,000 feet per minute for rods, and a production rate of 50 to 70 tons per hour for merchant products. The mill produces rods, rounds, flats, angles, and light beams of various sizes.

Motor Room of new Mill. All electrical installations by Allegheny Industrial Electrical Co., Inc.



Reheating Furnace for 13" Mill — designed, built and installed by Rust Furnace Company.

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Automatic transport of billet, dummy and butt. Extensive automation to suit customer's requirements.

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Inside cooling and relative stroke of the mandrel to increase its life.

Pressure water station or self-contained oil-hydraulic drive—depending on the product, and on operating conditions.

Safe and quick operational sequence through preset sequence control. Numerous patents in Germany and other countries.

Technical data

Frame-type	power 350 up to 700 tons
Three-column type or four-column type	power 700 up to 3850 tons
Four-column type	power 850 up to 25,000 tons

Extrusion presses with floating mandrel or spider-type tools power 350 up to 25,000 tons. Production: from solid billets . . . . solid sections, wire (tubes). From hollow billets . . . . tubes, hollow sections

Extrusion presses with mandrel shifting device, power 350 up to 25,000 tons. Production: from hollow billets . . . . tubes, hollow sections. From solid billets . . . . solid sections, wire

Extrusion presses with piercer, power 700 up to 8,800 tons. Production: from solid billets . . . . tubes, hollow sections, solid sections, wire. From hollow billets . . . . tubes, hollow sections, solid sections, wire

Extrusion methods "with shell" from cast billets; "without shell, lubricated" from machined billets.

14,000 ton extrusion press for tubes and rods in the Lafayette Works of ALCOA, USA, for light metal billets up to 32 in. dia, 70 in. length, weight $2^1/_2$ tons. An additional press of this type is being built.

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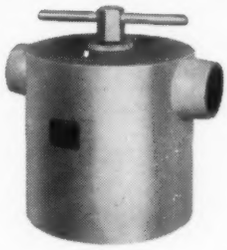

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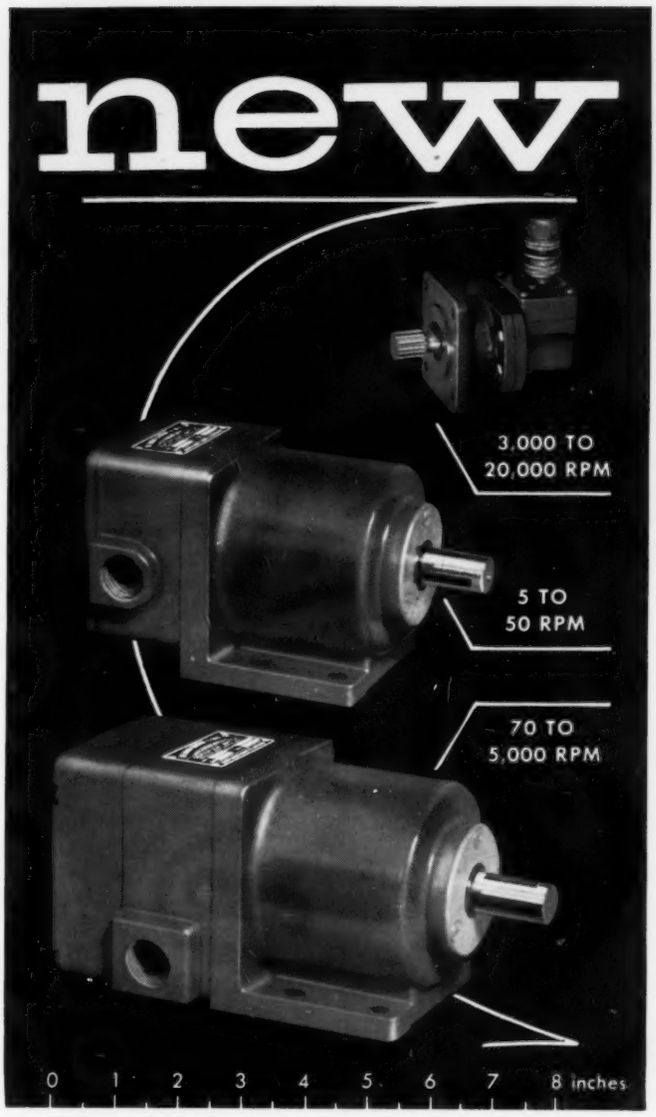

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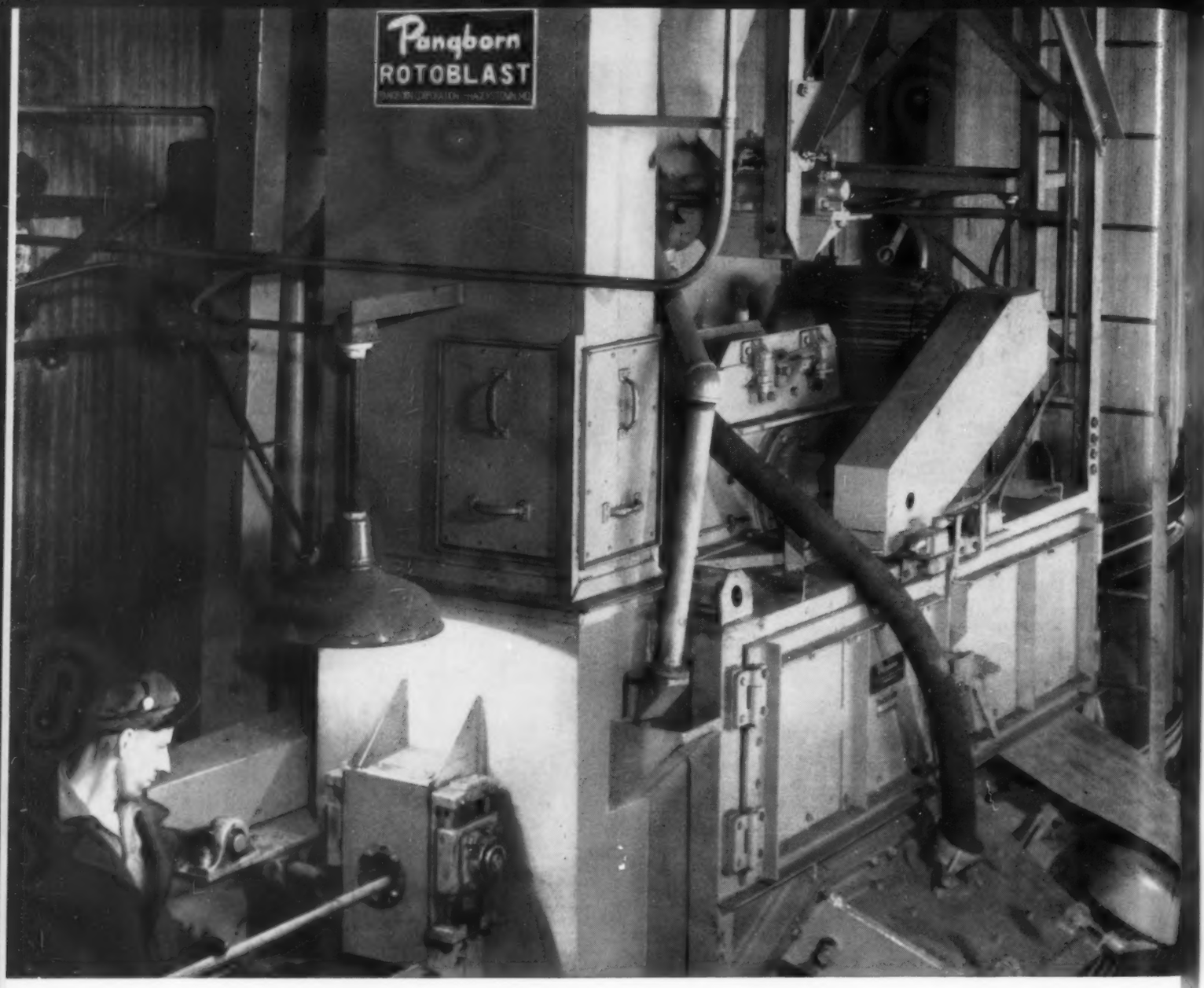

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Date-line Diary...

December 1

△ The AISI reports that the operating rate of the steel industry for the week of December 1 is scheduled at 2,013,000 tons (74.6 per cent of capacity). This compares with 1,988,000 tons one week ago (73.7 per cent capacity) and 1,831,000 tons one year ago. Index of production for the week is 125.3.

December 2

△ Automobile production in November, 1958 totaled 514,000 cars, nearly double the October, 1958 output, but 11 per cent behind November, 1957.

December 3

△ The agreement reached between John L. Lewis and the soft coal operators grants the 180,000 soft coal miners wages increases of $2 a day, $1.20 effective January 1, and 80¢ effective April 1, 1959. Also it increases to $200 miners' vacation pay from $180 at present and binds commercial operators (but not captive mines) to refuse to handle coal mined in nonunion pits.

△ The Commerce Dept. reported that commercial exports in October, 1958 topped $1,400,000,000, an increase of $200,000,000 over September, 1958 but $170,000,000 under October, 1957.

December 4

△ John L. Lewis asked for similar terms from coal producers in the South as he won in the settlement with northern soft coal industry.

December 5

△ The Aluminum Assn. reported that shipments of aluminum sheet and plate in October, 1958 totaled 109,830,000 lb, compared with 100,442,000 lb in September, 1958. Shipments of aluminum foil for October, 1958 totaled 18,678,433 lb compared with 17,399,141 lb in September, 1958.

△ Soft coal producers of the South fell into line and agreed to John L. Lewis' contract offer. Operators announced price increases would be established to offset wage increases gained.

△ Government figures disclosed that construction outlays for November increased the first 11-month total to $45,000,000,000, $700,000,000 over the same period in 1957.

△ The AISI reported that shipments of finished steel products during October totaled 6,224,540 net tons, compared with 5,386,292 net tons in September, 1958 and 6,550,690 tons in October, 1957.

△ The Bureau of Mines reported that the consumption of scrap during October, 1958 totaled 5,078,000 gross tons, pig iron used was 5,238,000 gross tons. This compares with 4,472,219 tons of scrap and 4,524,851 tons of pig iron in September, 1958.

△ The Bureau of Mines reported that production of Pennsylvania anthracite for November, 1958 totaled 1,585,000 net tons compared with 1,999,000 net tons in October, 1958 and 1,928,000 tons in November, 1957.

December 8

△ The Canadian Bureau of Statistics reported production of steel ingots at 380,369 tons in November, 1958 compared with 350,751 in November 1957; pig iron output for November, 1958 amounted to 253,497 tons compared with 266,415 tons in November, 1957.

△ The government asked for a perpetual injunction against any acquisitions by Bethlehem Steel Co. and Youngstown Sheet & Tube Co. that might lessen competition in the steel industry.

△ Auto dealers sales of new cars spurted to an average of 18,500 cars daily in the final third of November, 1958, 14.2 per cent above the mid-month pace, and the highest sales rate for any 10-day period in 1958.

△ The administration plans to cut the budget for the fiscal year beginning July 1, 1959 to around $78,000,000,000, compared with an indicated over $80,000,000,000 total for the year 1958–59. An expected gain of $7,000,000,000, to $8,000,000,000 in revenues in the 1959–60 year is hoped to trim the deficit to $2,000,000,000 or $3,000,000,000 at June 30, 1960 from the $12,000,000,000 deficit anticipated on June 30, 1959.

△ National Coal Assn. reports that soft coal production in 1959 will expand to 455,000,000 tons, 13.8 per cent above 1958.

△ The AISI reported that the iron and steel industry's payroll for 94.9 per cent of the industry for hourly and salaried employees totaled $326,307,323 during October 1958, against $294,277,422 in September, 1958. Average hourly payroll cost for wage earners was $3.241, compared with $3.274 in September, 1958 and $2.992 in October, 1957. Fringe benefits amounting to 33¢ per hr are not included. Total employment during October, 1958 totaled 540,590 compared with 527,407 in September, 1958; average hours worked per week in October was 39.1 compared with 36.5 in September.

△ The AISI reports that the operating rate of the steel industry for the week of December 8 is scheduled at 2,015,000 tons (74.7 per cent of capacity). This compares with 1,985,000 tons one week ago (73.5 per cent capacity) and 1,770,000 tons one year ago. Index of production for the week is 125.4.

December 9

△ The Supreme Court ruled that natural gas companies may put higher charges for gas into effect, subject to refund, pending investigation by the Federal Power Commission.

December 10

The AISI reports that steel output for November, 1958 amounted to 8,582,000 net tons compared with 8,817,778 tons in October, 1958 and 8,392,919 tons during November, 1957.

△ Federal agencies estimate that business spending for new plant and equipment will rise to a $29,900,000,000 pace in the final quarter of 1958, and reach a level of $30,500,000,000 annually in the first quarter of 1959; for the year 1958, such spending is estimated at $30,500,000,000, 17 per cent the record $37,000,000,000 in 1957.

December 11

△ The Commerce and Labor Depts. reported that unemployment held steady at 3,800,000 between mid-October and mid-November. The seasonally adjusted rate of unemployment fell to 5.9 per cent of the labor force on November 15.

December 15

△ Government figures showed that industrial production in November, 1958 rose to 141 per cent of the

1947–49 average 3 points over October, 1958; housing starts in November totaled 100,000, compared with 109,000 in October, 1958 and 75,700 in November, 1957.

Δ The AISI reports that the operating rate of the steel industry for the week of December 15 is scheduled at 2,036,000 tons (75.4 per cent of capacity). This compares with 1,985,000 tons one week ago (73.5 per cent capacity) and 1,742,000 tons one year ago. Index of production for the week is 126.7.

December 16

Δ The American Iron Ore Assn. reported that iron ore shipments down the Great Lakes in the 1958 season amounted to 52,800,000 gross tons, nearly 40 per cent under the 1957 total of 84,600,000 tons.

December 17

Δ The ARCI reports that deliveries of new domestic freight cars in November, 1958 totaled 1803 compared with 1951 in October 1958 and 7142 in November, 1957. Orders in November totaled 6295 compared with 781 in October and 1070 in November 1957. Backlog of cars on order as of December 1, 1958 stood at 27,962 compared with 23,670 on November 1, 1958 and 59,194 on December 1, 1957.

December 18

Δ American Telephone announced plans to split its stock three for one and proposes a 10 per cent boost in dividend rate. The added shares are expected to be distributed June 1, 1959; first quarterly dividend payment of 82½¢ is to be paid in July, 1959.

Δ The Commerce Dept. reported that personal income rose to an annual rate of $360,000,000,000 in November, an increase of $2,500,000,000 over the October, 1958 pace. The Department predicted that for all of 1958 personal income will reach $353,000,000,000, a gain of $5,000,000,000 over 1957.

December 19

Δ The Commerce Dept. reports that cash dividend payments by corporations issuing public reports declined to $298,000,000 in November, 1958, compared with $325,000,000 in November, 1957.

December 20

Δ The Aluminum Assn. reported that primary aluminum production in the United States during November, 1958 was 140,962 short tons compared with 139,836 short tons in October, 1958 and 135,024 tons in November, 1957.

December 22

Δ Stockholders will be asked to approve purchase of Aetna-Standard Engineering Co. by Blaw-Knox Co.

Δ Federal Judge Edward Weinfeld in the U. S. District Court signed a final decree banning the merger of Bethlehem Steel Corp. and Youngstown Sheet and Tube Co. and also barred the companies from carrying out "in whole or in part" their reorganization plan and agreement dated December 11, 1956.

Δ The Industrial Heating Equipment Assn. reported that new orders for industrial furnaces in November, 1958 were $5,597,000 compared with $3,105,000 in October, 1958. New orders for induction heating equipment in November, 1958 totaled $586,000, compared with $743,000 in October, 1958.

Δ The AISI reports that the operating rate of the steel industry for the week of December 22 is scheduled at 1,840,000 tons (68.2 per cent of capacity). This compares with 2,011,000 tons one week ago (74.5 per cent capacity) and 1,366,000 tons one year ago. Index of production for the week is 114.5.

Δ The AISC reports that bookings of fabricated steel in November, 1958 totaled 242,635 tons compared with 259,016 tons in October, 1958 and 217,959 tons in November, 1957. Shipments in November, 1958 totaled 271,088 tons, compared with 307,080 tons in October, 1958 and 334,083 tons in November, 1957. Backlog of future work as of November 30 totaled 1,838,860 tons.

December 23

Δ Custom smelter copper became generally established at 29¢ a lb, the same price as charged by larger domestic copper producers, when one firm which had been pricing its metal at 28¾¢ increasedi ts price ¼¢.

December 24

Δ Machine tool orders in November, 1958 amounted to $20,700,000, down 27 per cent from October, 1958, and also from November, 1957. For the first eleven months of 1958 orders fell to $248,000,000, off more than 50 per cent from the same period in 1957.

December 25

Δ The Commerce Dept. reports that the national output of goods and services in the current quarter is running at a rate of $453,000,000,000 yearly; however, actual production for all 1958 is estimated at $437,000,000,000, a decline of $3,000,000,000 from 1957.

Δ Appalachian Coals, Inc., marketing agency for several southern producers, is increasing prices of soft coal 15¢ to 25¢ a ton, designed to offset the $1.20 daily pay increase slated for the UMW January 1, 1959.

Δ The Venezuelan junta decreed an income tax hike it says will obtain for the government about 60 per cent of oil company profits, rather than the 50 per cent now being obtained.

December 26

Δ Electric power production last week rose above 13,500,000,000 kwhr, a new high and a gain of 9 per cent over the same period in 1957.

December 29

Δ President Eisenhower slashed $8,000,000,000 from the $85,000,000,000 spending authority requested by government departments for the next budget.

Δ The AISI reports that the operating rate of the steel industry for the week of December 29 is scheduled at 2,045,000 tons (75.8 per cent of capacity). This compares with 1,840,000 tons one week ago (68.2 per cent capacity) and 1,501,000 tons one year ago. Index of production for the week is 127.3.

December 30

Δ The F. W. Dodge Corp. reports that construction contract awards in November, 1958 amounted to $2,500,000,000, about 9 per cent above the total in November, 1957.

Δ Argentina was granted $329,000,000 of public and private credits to bolster its economy, including $125,000,000 from the U. S. Export-Import Bank, $75,000,000 from the International Monetary Fund and $54,000,000 from 11 private U. S. banks.

Δ The Aluminum Assn. reported that shipments of aluminum sheet and plate in November, 1958 totaled 97,979,000 lb, compared with 109,830,000 lb in October, 1958. Shipments of aluminum foil for November, 1958 totaled 17,440,712 lb compared with 18,667,318 lb in October, 1958.

December 31

Δ Inland Steel Co. acquires Vinson Steel & Aluminum Co., Dallas, Tex., which will be the company's first distribution outlet in the southwest. Vinson will be merged into Joseph T. Ryerson & Sons, Inc.

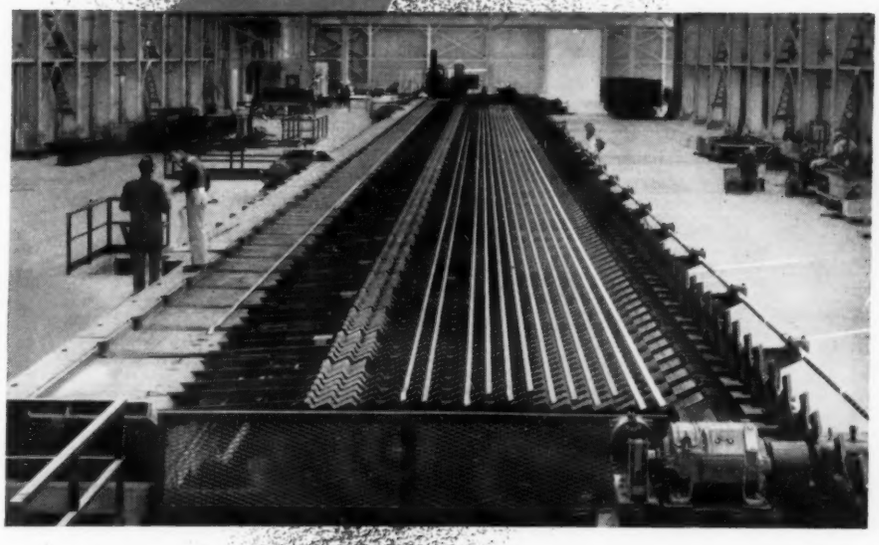
Δ Roger M. Blough, chairman of U. S. Steel Corp., predicts that steel operations for the industry as a whole have prospects of averaging 80 per cent capacity in the first half of 1959, which would compare with a 74 per cent production rate for the final three months of 1958.

MORGAN MILLS
MORGAN QUALITY

from START to FINISH

MERCHANT AND ROD MILL
Atlantic Steel Company
Atlanta, Georgia

Morgan engineered and equipped from charging car to cooling bed this new Atlantic Steel Mill is now in full operation. This mill is just one of two hundred and twenty-one Morgan continuous rolling mills which have been purchased by steel plants throughout the world.



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MORGAN CONSTRUCTION CO., Worcester, Massachusetts

Rolling Mills • Morgoil Bearings • Wire Mills • Regenerative Furnace Control • Ejectors • Gas Producers

RM 72

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shaping metal for all industry

The Ohio Steel Foundry Co.

Lima, Ohio

Plants at
Lima and Springfield, Ohio

LIMA... Virtually at the center of the steel industry

Industry News...

WILPUTTE AWARDED J&L COKE OVEN CONTRACT

△ Allied Chemical Corp.'s Wilputte Coke Oven Division has been awarded a contract by Jones & Laughlin Steel Corp. for the engineering and construction of 59 coke ovens at the Pittsburgh Works, Pittsburgh, Pa.

The new battery, being built on the site of 60 old ovens, is scheduled for completion late this year.

When completed, the 59 ovens will have a capacity to carbonize 1440 tons of coal daily. Auxiliary equipment to be designed and constructed by Wilputte include coal handling facilities, coal bin and coke quenching station.

A rotating table charging car, feeding coal mechanically into the ovens, will permit charging rapidly with a minimum of smoke emersion.

A Wilputte pusher machine with one-position stop for door removal and coke pushing will represent an improvement over older types which required several machine movements.

Seventeen tons of coal will be loaded at once into each of the new ovens. It will take 17 hr of 2500 F heat to turn the coal into coke. The coke will then be sprayed with 8000 gal of water in a matter of minutes to cool the coke before it is screened for blast furnace use.

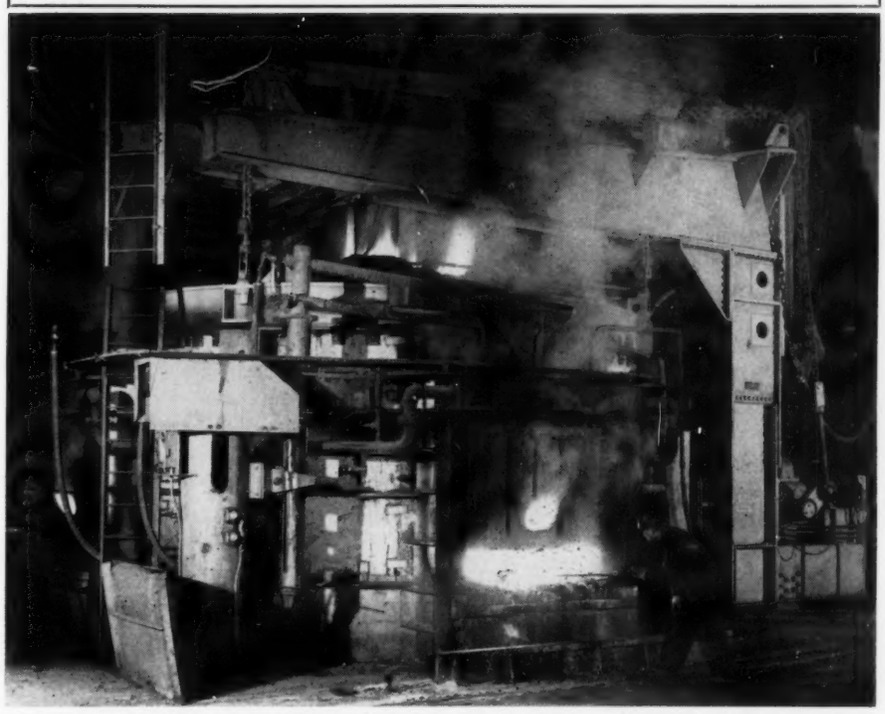
AWARD MESTA CONTRACT FOR GALVANIZING LINE

△ Contracts covering the design and manufacture of a 48-in. heavy gage continuous galvanizing line for the Springhill Works of Lysaght's Works Proprietary, Ltd., of Port Kembla, New South Wales, Australia, have been awarded to Mesta Machine Co.

The line will be designed to process coiled mild steel strip 0.012 to 0.060 in. thick, 18 to 48 in. wide, at a speed of 360 fpm. The entry coil feeding equipment will be designed to handle coils up to 72 in. in diam, with a maximum weight of 36,000 lb, and will include two mandrel type pay-off reels with elevating loading buggies, and an automatic welding unit to join the coils into a continuous strand.

The delivery equipment will include a tension reel with elevating stripper and automatic edge position control, and a combination flying shear and leveler, and will be designed to deliver finished coils weighing up to 20,000 lb, or sheets in lengths from 4 ft to 16 ft.

ADD ELECTRIC FURNACE AT DUQUESNE WORKS



This new electric-arc steelmaking furnace, with auxiliary equipment, just placed in operation at U. S. Steel Corp.'s Duquesne Works will enable that plant to produce vacuum-cast ingots measuring 110 in. in diameter and weighing 480,000 lb. Ingots cast in the vacuum chambers are virtually free of hydrogen gas, thus eliminating internal ruptures when the steel is forged and machined into rotors for giant electric-power steam turbines. To vacuum cast the 110-in. ingots, 80-ton heats of steel made in the new furnace and two others of comparable size must be ready simultaneously. One after another, each heat is poured without interruption into the vacuum chamber containing the ingot mold. Previously, only two large heats were available at one time with the result that 95-in. ingots were the largest that could be produced. The new furnace, fifth installed at Duquesne since the electric furnace shop was built during World War II, will increase the plant's capacity for producing stainless and high alloy steels by approximately 75,000 tons per year to a new total of 294,000 tons.

FORM NEW ELECTRICAL CONTRACTING COMPANY

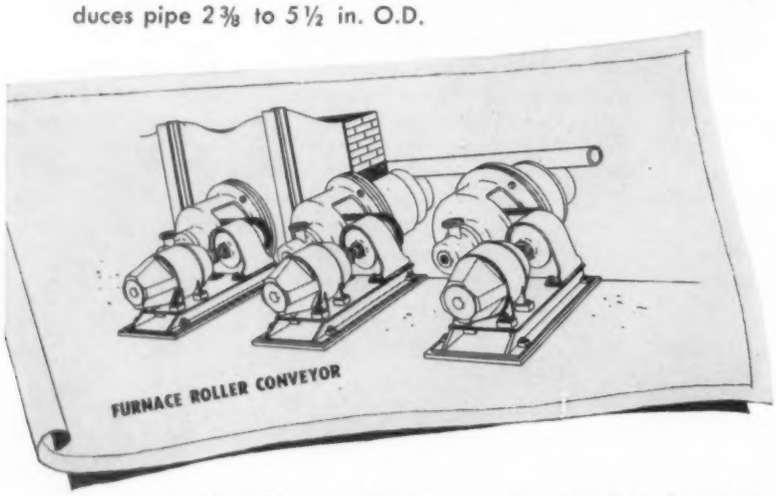
△ Formation of a new electrical contracting firm to assume and continue the electrical construction business of The Dingle-Clark Co. has been announced. The electrical construction organization will become The W. W. Clark Corp.

President and treasurer of the new corporation is Willis W. Clark. Other executives include C. A. Martin and C. W. Cristal, vice presidents, and Francis Bogovich, secretary, who have been associated with Mr. Clark for many years. Home offices of the corporation will remain in the Engineers Building, 1365 Ontario St., Cleveland, Ohio.

The Dingle-Clark Co. was founded in 1918 by Mr. Clark and Howard Dingle. The management personnel of the electrical contracting business will continue with Mr. Clark in the

Enterprise feeds it HOT...

Enterprise water-cooled conveyor units take billets through a Loftus Furnace at Youngstown Sheet & Tube Company and feed them to the stretch mill. The individually-driven conveyor units handle billets about 7 in. in diameter. The mill, completed in 1958, produces pipe 2⅜ to 5½ in. O.D.



For this same Youngstown Sheet & Tube installation Enterprise also provided a stretch mill decelerating conveyor, inlet table, heavy-duty middle-cut saw, cooling racks, and discharge conveyor.

For conveyor applications of special design, always talk to Enterprise engineers.

ESTABLISHED 1870

the Enterprise company

COLUMBIANA, OHIO

new corporation, while the machinery sales personnel of The Dingle-Clark Co. will remain with that organization. The Dingle-Clark Co. will continue to serve as sales representatives of The Cleveland Worm & Gear Co., The Farval Corp., The John Waldron Corp., and, in the Pittsburgh territory, The Terry Steam Turbine Co. of Hartford, Conn.

LACLEDE SKELP MILL TO BE REBUILT BY UNITED

△ The United Engineering and Foundry Co. announces that it has been awarded a contract by Laclede Steel Corp. for rebuilding and modernizing the 10-in. skelp mill at their Alton, Ill., plant.

Included in the equipment will be new billet handling equipment at the entry side of the furnace, five new roughing mills, a new down and upcut shear, two new edgers, strip handling conveyors and rolls. Upon completion the mill will be capable of producing skelp up to 16 in. in width, and with the new coiling and handling equipment, will have greatly increased capacity.

The mill is expected to be in operation by the end of the year.

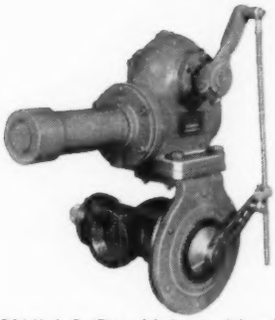
EATON MFG. PROPOSES TO ACQUIRE WORM & GEAR

△ Directors of Eaton Manufacturing Co. and Cleveland Worm & Gear Co. at separate meetings approved a transaction whereby Eaton will acquire the assets and business of Cleveland Worm & Gear and its wholly-owned subsidiary, The Farval Corp.

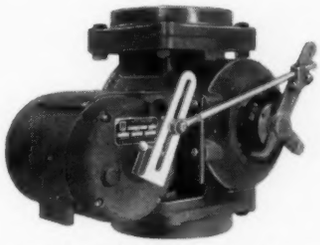
An announcement by John C. Virden, chairman and president of Eaton, and Howard Dingle, chairman of Cleveland Worm & Gear, said that following approval by shareholders of the latter company, a total of 81,670 shares of Eaton's capital stock would be exchanged on a share-for-share basis for an equal number of Cleveland Worm & Gear shares currently outstanding.

The executives stated that upon completion of the transaction, now scheduled for January 31, 1959, Cleveland Worm & Gear would be operated as a wholly-owned subsidiary of Eaton under the guidance of its present management and with no changes in personnel, products or sales policies.

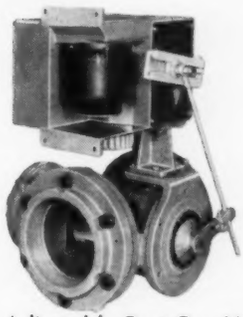
WIDELY USED
ADJUSTABLE PORT VALVES
by North American



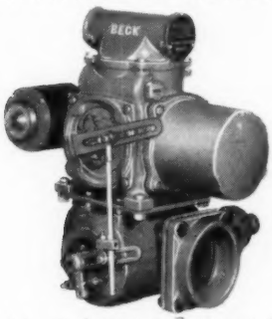
2½" A P Gas Valve — North American Hydraulic Operator



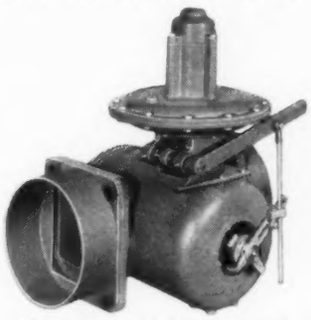
6" Adjustable Port Air Valve Minn.-Honeywell Elec. Operator



4" Adjustable Port Gas Valve Leeds & Northrup Elec. Operator



4" Air and 1½" Gas A P Valves Beck Electric Operator

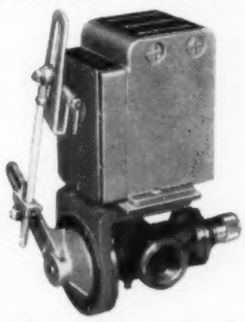


10" A P Air Valve — North American Pneumatic Operator

6" Air, ¾" Oil, and 2" Gas A P Valves — ATC Electric Operator

1½" Adjustable Port Gas Valve Conoflow Pneumatic Operator

12" Adjustable Port Air Valve Bristol Pneumatic Operator



1¼" Adjustable Port Gas Valve Barber-Colman Elec. Operator

for HOT or COLD AIR, GAS, OIL, WATER, STEAM
special materials available for other fluids

LOW TORQUE • ROTARY PLUG • EASILY CLEANED
Pressure Drop Adjustable for Best Flow Characteristic

NORTH AMERICAN for COMBUSTION and Hydraulic Controls

The North American Mfg. Co.
Cleveland 5, Ohio

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. . . steel mill work roll, back-up roll, roll neck bearings ready to ship!

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Why carry heavy inventories of these expensive bearings? Our large stocks for replacement "on the mill" or "off the mill"—bearings for all types of mill tables, coils, cranes and mill motors as well as ingot car bearings and pallet wheels can be ordered and delivered immediately!

No other bearing distributor carries a comparable stock of steel mill bearings ready for every emergency. If you want steel mill bearings in a hurry, call or write NOW!

Shown in the photograph are only a few of the many steel mill bearings in stock. Left, a SKF Back-up Roll Thrust Bearing sits on a 2,000 lb. Timken Back-up Roll Bearing. Center, Timken Work Roll Bearings and Rollway Self-Aligning Thrust Bearings. Right, in boxes, are a pair of matched Timken Back-up Roll Bearings.

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WEST VIRGINIA: Charleston • Huntington • Parkersburg • Wheeling • **NEW JERSEY:** Camden
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JANUARY, 1959

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Note: Post cards expire three months after publication date.

(1) Steel-Aluminum Data Book

Joseph T. Ryerson & Son, Inc. has issued a new edition of their pocket size data book. This book includes aluminum analyses, characteristics, mechanical properties and tolerances. Other information on steel, such as machining and fabricating data, manufacturing practices and tolerances, weights, safe loads, ASTM standards, compositions and properties, and miscellaneous facts of value to purchasing agents, engineers and shop men are included.

(2) Worm Gear Speed Reducers

DeLaval Steam Turbine Co., has published a bulletin describing their durable worm gear speed reducers. Complete horsepower and torque data for these worm gear units are given in full-page tables. Dimensions of these units in various sizes are diagrammed and tabulated in detail. Materials and design of the interchangeable components are also described. (Bulletin 5018)

(3) Metal-Clad Switchgear

A new bulletin describing in detail its line of 4160-volt metal-clad switchgear has been published by I-T-E Circuit Breaker Co. The bulletin covers the complete line of indoor, and standard and walk-in outdoor type equipment with ratings through 3000 amp continuous-current and 350-MVA interrupting capacities. New outdoor walk-in switchgear is described in a separate bulletin section. Construction and performance features, ratings and dimensions are furnished. Separate bulletin sections provide schematic drawings, dimensions, preferred locations and arrangements of the various circuit elements for indoor and outdoor type equipment. Panel layouts and dimensions for standardized units are provided, followed by a simplified ordering guide which includes general written specifications and listings of individual equipment for each switchgear unit. A final section illustrates and describes such available accessories as manual and electrical grounding and testing devices, test control stations and outdoor removal trucks. (No. 2804-1A)

(4) Motor Bulletin

The Louis Allis Co., has published a four-page bulletin on its new drip-proof pancake motor that reduces motor length up to 54 per cent over standard motors. The bulletin presents full engineering information on this flange type motor of conventional radial air-gap design that is intended for use on machine tools, roof-ventilating fans and other space-cramped applications. A cutaway drawing shows how the motor achieves its short length through formed end coils and a one piece housing-bearing bracket. Additional motor features presented are: rugged cast iron construction, modern appearance, factory lubricated bearings and quiet operation. (Bulletin 2150)

(5) Carbon-Graphite Brochure

A complete informative reference on the composition, qualities and applications of carbon-graphite is offered by the Ohio Carbon Co. in the form of an eight-page brochure. The brochure serves as an idea book for carbon-graphite applications Charts and tables provide data.

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53	CLARK CONTROLLER CO., THE	BULLETIN 106B	Brakes
54	CLEVELAND WORM AND GEAR CO.	BULLETIN 145	Speed reducers
55	CUTLER-HAMMER, INC.	BULLETINS EN64-A232 & EN65-A232	Speed drives
56	ELECTRIC CONTROLLER & MFG. CO., THE SQUARE D CO.	BULLETIN 6400	A-c crane control
57	ELECTRIC MACHINERY MFG. CO.	E-M SYNCHRONIZER NO. 42	Synchronous motors
58	ELLIOTT CO.	BULLETIN Q-23A	Elliott equipment for steel industry
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72	STAMCO, INC.	BULLETIN SC55	Slitting & coiling equipment
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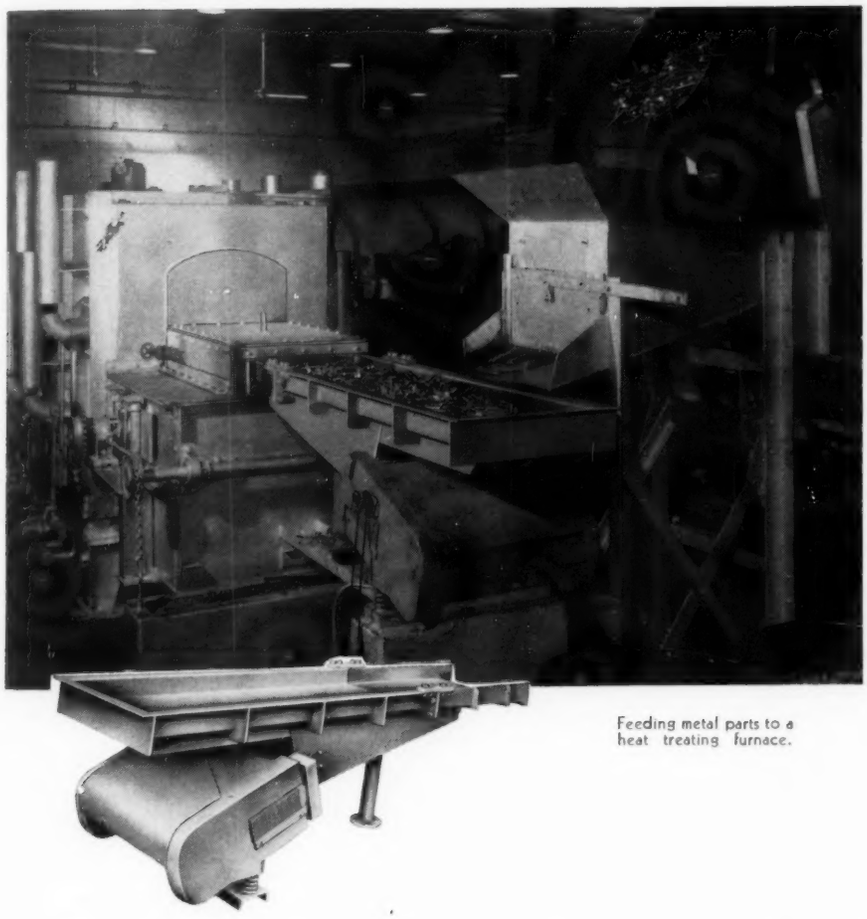
SYNTRON Vibra Flow

VIBRATORY FEEDERS

with variable control of flow rate



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help cut heat-treating costs!

—by providing a smooth flow of metal parts to continuous heat treating furnaces.

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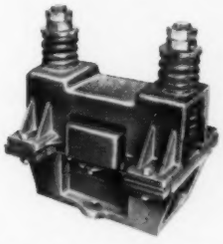
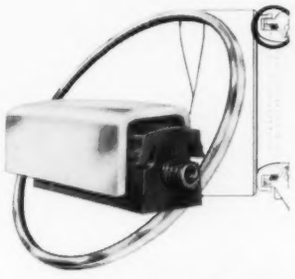
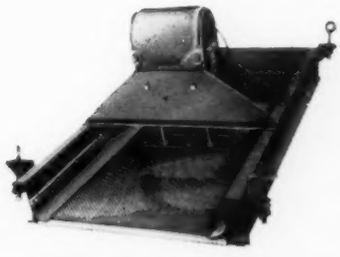


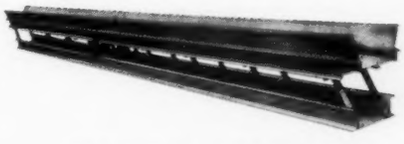
BIN VIBRATORS



ROLL NECK SEALS



VIBRATING SCREENS



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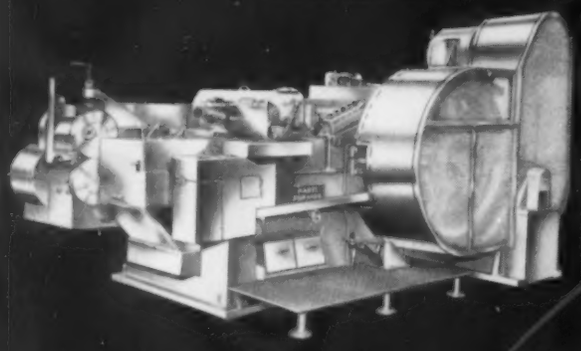
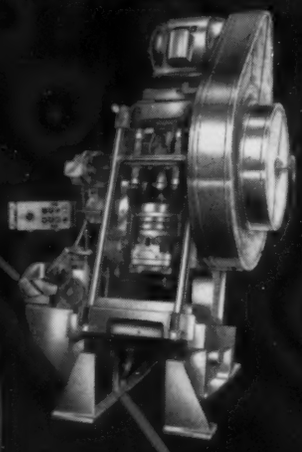


POWER PRESSES



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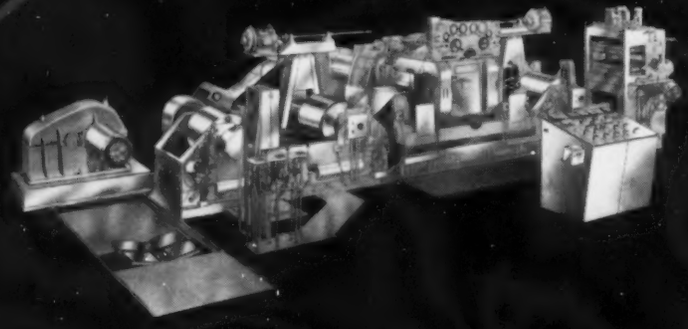

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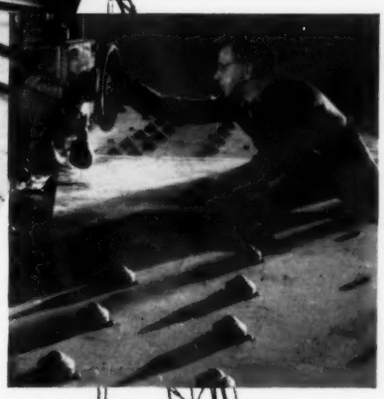
WF-54



Cutting through the Complexities of a Material Handling project

Sharp, creative engineering . . . hard practical experience . . . modern fabrication facilities . . . efficient construction organization. These are the resources you can command at Roberts & Schaefer to cut through a maze of complex problems to get the material handling facilities you want: a plant with all necessary processing, distributing and storage systems . . . a plant with efficient performance, economy and flexibility.

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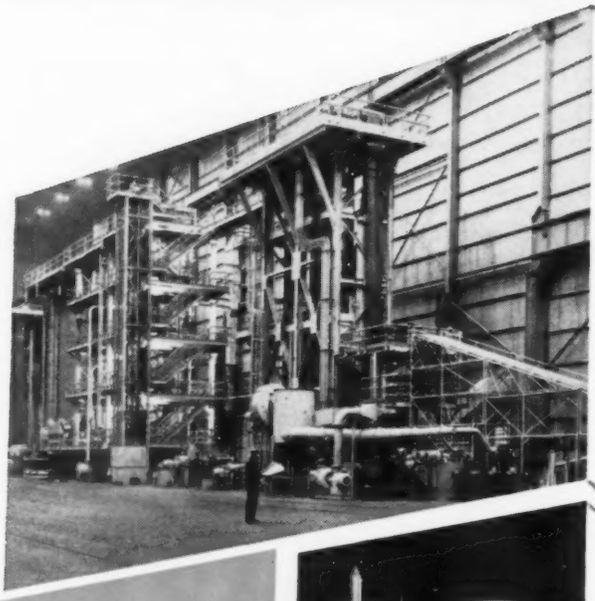
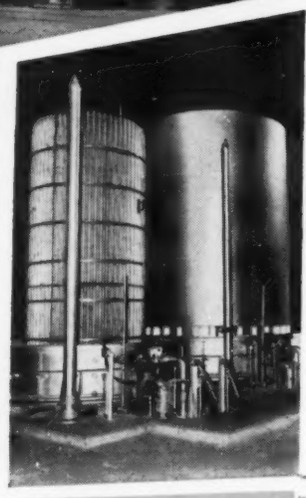
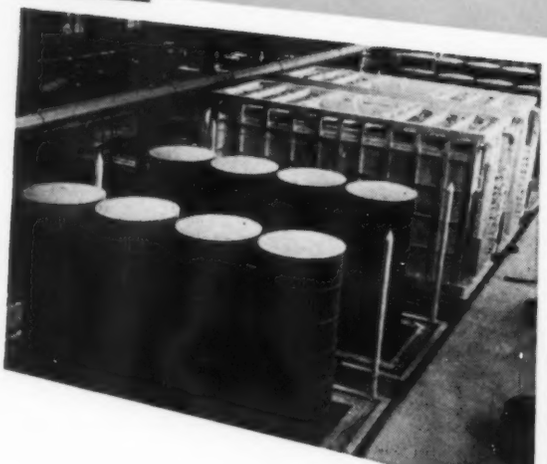


VERTICAL STRIP ANNEALER



SINGLE-STAND ANNEALERS

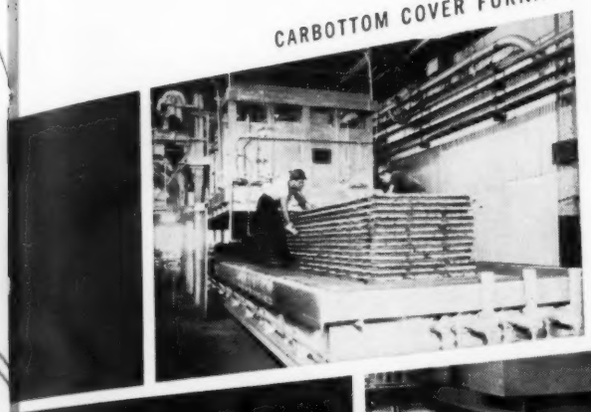
CONTINUOUS STRIP GALVANIZER

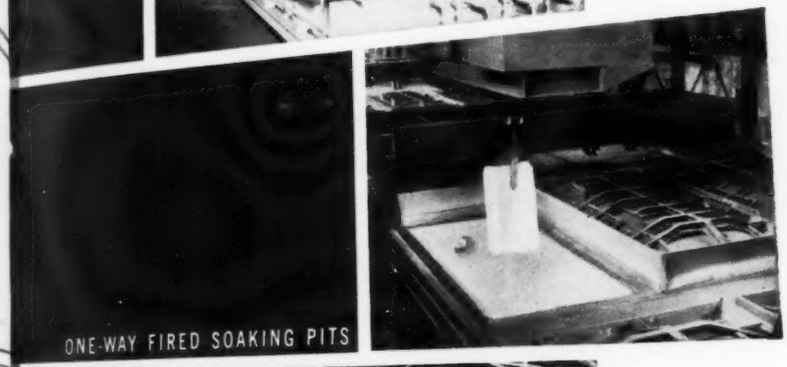


MULTIPLE-STAND ANNEALERS

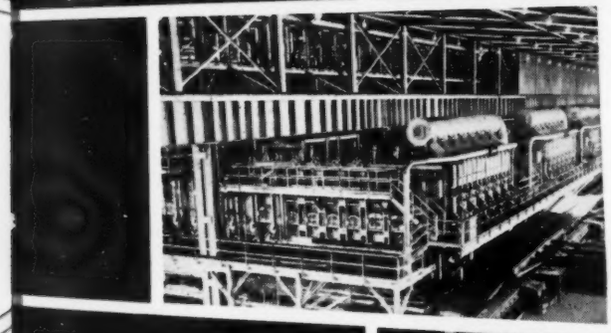
foundation for steel mill profits

CARBOTTOM COVER FURNACE

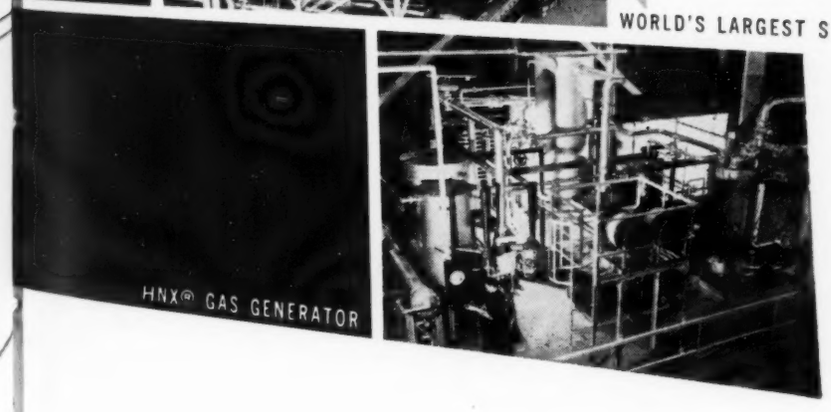




ONE-WAY FIRED SOAKING PITS



WORLD'S LARGEST SLAB HEATER



HNX® GAS GENERATOR

You put a solid foundation under your profits whenever you specify Surface equipment. Whatever type it may be, you know it is supported by many interlocked blocks of know-how in heating and handling steel.

The technical skills which Surface has developed in building soaking pits will benefit the man who buys Surface annealing covers. In the same way, Surface concepts of slab heating contribute to high-speed stress relieving . . . carbon restoration to strip annealing . . . controlled atmospheres to wire patenting.

Because of this broad and deep foundation of experience, Surface can improve any single process in the context of a complete sequence of operations. This is to the customer's profit, as many companies will confirm.

Surface Combustion Corporation, 2404 Dorr St., Toledo 1, Ohio. In Canada: Surface Industrial Furnaces, Ltd., Toronto, Ontario.

Surface

wherever heat is used in industry

ASSOCIATED COMPANIES: British Furnaces, Ltd., Chesterfield • Stein & Atkinson, Ltd., London • Stein & Roubaix, Paris • S. A. Belge, Stein & Roubaix, Bressoux, Liege • S. A. Forni Stein, Genoa • Chugai Ro Kogyo Kaisha, Ltd., Osaka

Shearing* LINES

Designed and Built by MESTA

Mesta 60" Sheet Shearing Lines with Trimmers and Combination Rotary Flying Shears and Levellers Operating at McLouth Steel Corporation, Gibraltar, Michigan

* HIGH-SPEED SHEARING, SIDE TRIMMING AND CUTTING EQUIPMENT FOR SHEET AND TIN GAUGE STRIP STEEL

Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

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THERE IS NONE BETTER

Personnel News...

Albert H. Shonkwiler, formerly general manager of the Steubenville Works, Wheeling Steel Corp., was named assistant vice president in the Operations Division in charge of operational planning. Mr. Shonkwiler has been general manager of the Steubenville Works since 1955 and was assistant general manager from 1950 to 1955. Prior to that, he had been associated with Bethlehem Steel Co. and Otis Steel.

H. Nelson Lang was appointed general manager, succeeding Mr. Shonkwiler. Mr. Lang joined Wheeling Steel in 1931, working in the labor department of the Yorkville Works. In 1935 he was transferred to the general offices in Wheeling as assistant manager of production. He returned to the Yorkville plant three years later as a tandem mill foreman. In 1939, he was assigned the position of production engineer at the Steubenville Works. In 1947 he became assistant to the general manager, Benwood Works, and, in 1947, was made assistant superintendent, Tube Mill Department at that plant. He was promoted to superintendent in 1950 and, since 1955, has been general manager of the Benwood Works.

Joseph H. Girdler has been named manager of West Virginia Works, Connors Steel Division, H. K. Porter Co., Inc., succeeding **Astor L. Thurman** who has resigned. Mr. Girdler was formerly assistant to the division vice president. Prior to joining Connors Steel Division, Mr. Girdler was vice president of operations for Atlantic Steel Co.

L. M. Hoopes has been named superintendent of Republic Steel Corp.'s Warren, Ohio, coke plant, succeeding **J. H. Kunkle** who has taken a position with the Donner Hanna Coke Corp. in Buffalo, N. Y. **W. C. Thompson** has been appointed chief shipper of the district, taking over the duties of **J. J. Keil** who has retired. Mr. Hoopes joined the company in 1950 as a turn foreman at the Warren coke plant. He became heater foreman in 1954 and a year later was promoted to general foreman of the coke plant, the position he held until receiving his new assignment. Mr. Thompson has been with Republic since 1922 when he started at the Warren plant as a motor inspector helper. He subsequently served as billing clerk and as foreman in the hot strip mill, then was made shipper for the cold strip mill. He also is a member of the corporation's shipping committee.

B. H. Carmichael, for seven years assistant general superintendent of Interlake Iron Corp.'s Toledo, Ohio, plant, has been appointed general superintendent. He succeeds **J. Lindsay Johnson,** who has been made head of the new department of planning and development in the company's Cleveland headquarters. **J. B. Kaminski,** formerly assistant blast furnace superintendent at Interlake Iron's Chicago plant, has been named blast furnace superintendent in Toledo and **Gaylord Woodward,** formerly blast furnace supervisor in Toledo, has been appointed assistant blast furnace superintendent in Chicago.

Edward N. Fleming has joined Green River Steel Corp. as superintendent of maintenance. Previously he was assistant to the executive vice president of the H. H. Robertson Co., Ambridge, Pa. From 1949 through 1953, Mr. Fleming was plant engineer of the Worth Steel Co., Claymont, Del.

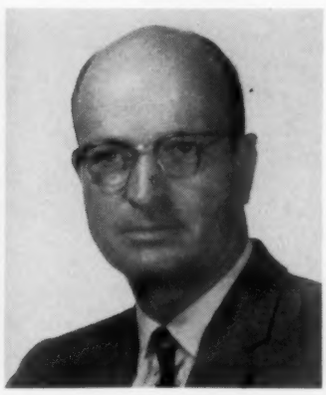
Robert P. Bremner was elected vice president—raw materials, The Youngstown Sheet and Tube Co. At the same time, **Donald S. Day** was elected vice president—traffic; **Dr. Karl L. Fetters** vice president—research and development; and **James D. Sloan,** vice president—purchasing.

Mr. Bremner joined Youngstown Sheet and Tube in 1948 and was appointed mining engineer. In 1951 he was advanced to assistant to the vice president in charge of operations and in 1955 was made manager of mining operations. In 1956 Mr. Bremner became assistant vice president. Mr. Day joined the Company in 1954 as assistant general traffic manager. He became general traffic manager in 1956, and now holds that position. Dr. Fetters joined Youngstown Sheet and Tube as open hearth metallurgist in 1936. In 1943 he became special metallurgical engineer on the staff of the operating vice president. He was named assistant to the vice president in charge of operations in 1950 and became assistant vice president in 1956. Mr. Sloan began work as a clerk in the Merchant Mill of

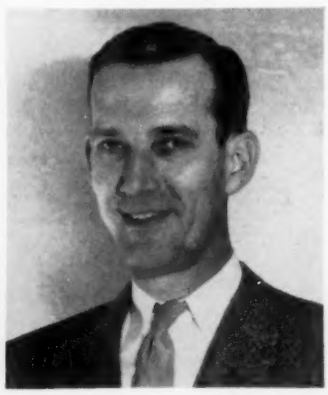
A. H. SHONKWILER

H. N. LANG

J. H. GIRDLER



L. M. HOOPES



C. A. WISKOFSKE

R. A. BECHTOLD

J. T. FOSTER

J. L. JOHNSON

Youngstown Sheet and Tube in 1929. After advancing through various positions he became purchasing agent in 1945. In 1956, Mr. Sloan assumed supervision on all of the activities of the purchasing department.

Clarence A. Wiskofske has been named superintendent of the Open Hearth Department, Republic Steel Corp., Massillon, Ohio, succeeding **Arch Swier,** who died November 10. **Robert A. Bechtold** succeeds Mr. Wiskofske as assistant superintendent of the Open Hearth Department, and **James T. Foster** has been appointed assistant superintendent of the plant's blooming and bar mills, succeeding **Peter T. Reynolds,** who retired November 30 after more than 38 years with the company. Mr. Wiskofske, who has been assistant superintendent since 1948, is a veteran of more than 34 years' service with Republic, all of which was spent in the Massillon plant's Open Hearth Department. He started in 1924 as a third helper. Mr. Bechtold, who has been a general stocker foreman in the Open Hearth Department since 1950, is a veteran of 12 years' service with Republic. Mr. Foster is an 18-yr veteran with Republic and has been turn foreman in the 12 and 18-in. bar mills at Massillon since 1946. He joined Republic in 1940. Mr. Reynolds started his Republic career in 1920 as a roll turner. He later was roll shop foreman and roll designer before being named assistant superintendent in 1952.

J. Lindsay Johnson, general superintendent of Interlake Iron Corp.'s Toledo, Ohio, plant, has been appointed head of the company's newly-created department of planning and development. Mr. Johnson joined the Toledo plant in 1923 as a chemist, was transferred to the operating department in 1933 and moved through a succession of supervisory positions, becoming blast furnace superintendent in 1945. He was appointed general superintendent in 1951.

L. H. Rader has been appointed superintendent—Rolling and Finishing Mills, at A. M. Byers Co.'s Ambridge, Pa., plant. At the same time, **Edward A. Turner** was named maintenance superintendent, and **H. S. Stevenson,** Manager—Conditioning Department. Mr. Rader was formerly employed as a roll designer by Jessop Steel Co., and was also associated with Bethlehem Steel Co., in Johnstown, Pa. Mr. Turner was formerly maintenance superintendent with the Vanadium Corp. of America. Mr. Stevenson was previously employed by Crucible Steel Co. of America as superintendent of the Conditioning Department at the Midland, Pa., plant.

Gilbert R. Semans has been appointed chief steel metallurgist of A. M. Byers Co. Mr. Semans was formerly director of metallurgy at Jessop Steel Co., research associate and director of the metallurgical laboratory at Universal-Cyclops Steel Corp., and was also employed by Kennametal Inc.

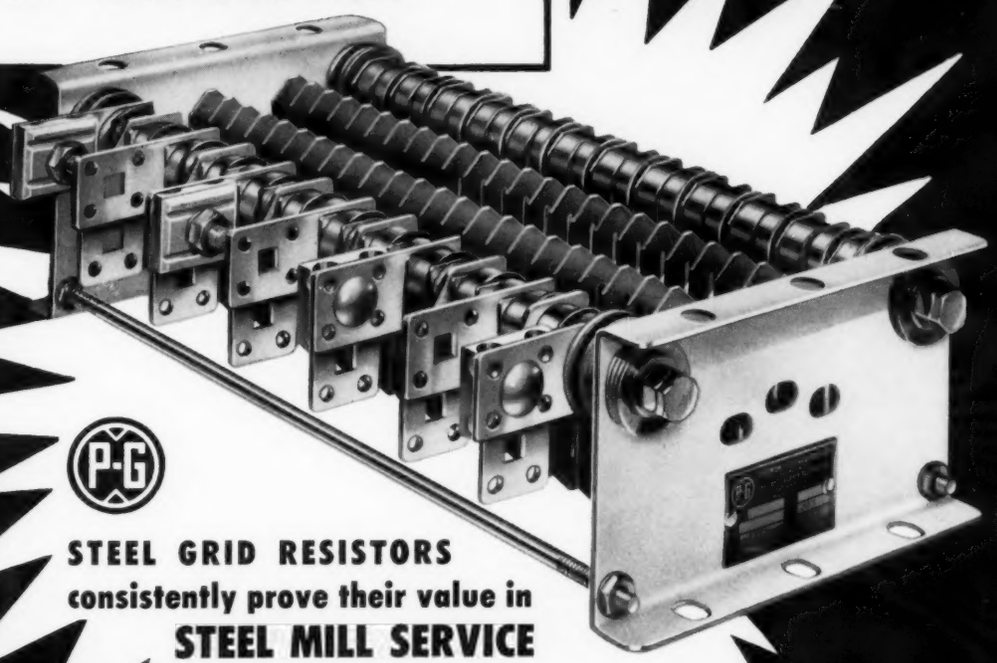
Robert W. Kamerer has been appointed superintendent of the South Processing Department of the Butler, Pa., Works of Armco Steel Corp. Mr. Kamerer was formerly works industrial engineer. **Charles G. Winters** will take over Mr. Kamerer's former post. Mr. Winters held the position of senior industrial engineer prior to his promotion.

David C. Haney has been appointed superintendent and **Hugh L. Kells** assistant superintendent of the Fuel and Power Department, Youngstown district, The Youngstown Sheet and Tube Co. Mr. Haney,

L. H. RADER (left)
E. A. TURNER (center)
H. S. STEVENSON (right)

IT'S THE *Built-in Quality* THAT COUNTS!

Designed to fit your present resistor space



STEEL GRID RESISTORS
consistently prove their value in
STEEL MILL SERVICE

P-G has BOTH!

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Write for Bulletins

By use of those durable raw materials . . . steel and mica, and the P-G exclusive features of design, these Steel Grid Resistors have the "built-in quality" to overcome factors which often cause resistor failures. Vibration, moisture laden or corrosive atmospheres have little effect on continuity of service. Try Post-Glover Resistors for heavy duty applications where resistors are subject to severe service . . . continuous "Trouble-Free" performance is assured.

The Nonbreakable Steel Grid Resistor

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ESTABLISHED 1892

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OFFICE and FACTORY—Kenton Lands Road, Erlanger, Kentucky

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Look Overhead... see "NORTHERN"

Versatility—when and where you need it!

LOCATION
In an automotive industry tool and die shop.

SPAN
84-feet, centers of runways

CAPACITY
40 tons on main hook—
10 tons on auxiliary hook

Overhead material handling in an automotive tool and die shop requires maximum versatility and fine control. The overhead crane may be called upon to spot a heavy duty press for try-out; to handle heavy body or chassis dies; and to move lighter, miscellaneous dies. Fast, safe precision handling for all such tooling is essential to cooperate with customers' requirements.

The NORTHERN Crane shown was installed in a heavy die shop. It provides flexibility, saves time, facilitates try-out, and is convincing that this shop is equipped to handle big responsibilities in a big way!

NORTHERN Hi-Lift Cranes — up to 20 tons — and NORTHERN Super Cranes — up to 150 tons — and up to 125 feet in span, provide a wide range of choice, and versatility when and where you need it.

Please consult with us before you invest in overhead cranes and hoists.

NORTHERN MATERIAL HANDLING EQUIPMENT

NORTHERN ENGINEERING WORKS
210 CHENE ST. • DETROIT 7, MICH.

J. D. WILLIAMS

H. F. HODGKINS, SR.

E. C. PETERSON

J. M. KNOX

assistant superintendent since 1957, succeeds **Emil A. Vierow,** recently appointed assistant to the district manager. Mr. Kells has been instrument repair foreman since 1955.

John D. Williams has been elected president of Lipe-Rollway Corp. and Rollway Bearing Co., Inc. Mr. Williams succeeds **H. Follett Hodgkins, Sr.,** who becomes chairman of the board. Other management changes include the appointment of **Robert M. Zimmerman** to the post of vice president, Lipe-Rollway Corp., and **H. Follett Hodgkins, Jr.,** is vice president of Rollway Bearing Co., Inc.—wholly-owned subsidiary.

Edward C. Peterson has been elected to the board of directors of the Birdsboro Steel Foundry & Machine Co. He is vice president of the company's Rolling Mill Equipment Division. Mr. Peterson joined Birdsboro in 1940 as assistant to the secretary and treasurer. In 1945 he became assistant to the chief engineer. In 1954 he was appointed assistant vice president—engineering, and in 1956 he was named to his present post.

James M. Knox has been elected president of Research-Cottrell, Inc. The retiring president, **Carl W. Hedberg,** will continue as a director of both Research-Cottrell and the parent Research Corp. Mr. Hedberg had served with Research Corp. for 35 years and had been the first president of Research-Cottrell, since 1954. Mr. Knox previously had served as executive vice president since early this year. He had joined Research Corp. as financial vice president in 1951, and since the formation of Research-Cottrell, Inc. in 1954, had also been secretary-treasurer and a director of the subsidiary company. Prior to joining Research Corp. he was assistant director and business manager of the Brookhaven National Laboratory from 1947 to 1951.

Mitchell P. Kartalia, manager of Square D Co.'s marketing division, has been elected a vice president. Mr. Kartalia, who had been previously sales manager of Square D's distribution equipment division, makes his headquarters in the Detroit, Mich., executive offices.

Thomas W. Morrison was named assistant to the engineering and research vice president, SKF Industries, Inc. **Tibor E. Tallian,** former supervising research engineer, was advanced to manager of the research laboratory. Simultaneously, **Frank W. Wellons** was named chief engineer. He formerly was assistant chief engineer.

E. S. Esary, formerly sales representative at Granite City, Ill., has been transferred to the Avonmore, Pa., sales office of General Steel Castings Corp. Mr. Esary, who has been with General Steel since 1941, served as a welder and in the product engineering and service departments before joining the sales department in 1951.

Walter C. Thompson was elected chairman of the board, The Torrington Co. **Milton E. Berglund** was elected to the office of president, succeeding Mr. Thompson. **Rodney T. Dunlap** was elected executive vice president. Mr. Thompson, who has been a director since 1946, joined Torrington in 1927 and served

M. P. KARTALIA

T. W. MORRISON

E. S. ESARY

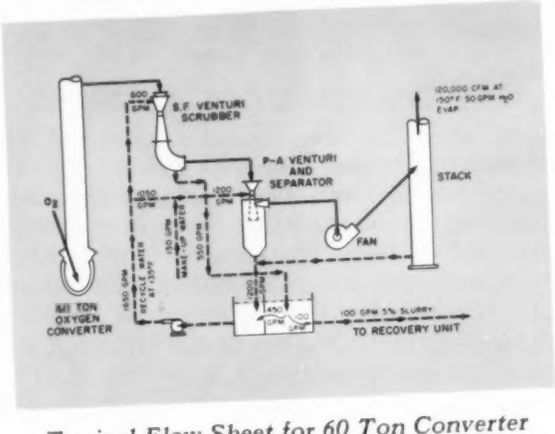
M. E. BERGLUND

NOW THERE ARE SIX OXYGEN STEEL CONVERTERS USING CHEMICO VENTURI GAS WASHERS...

The recent installation of Chemico gas scrubbers at a major steel plant in Canada marks the sixth time venturi gas washers have been used to stop an extremely undesirable source of air pollution – iron oxide fumes. Chemico venturi scrubbers maintain leadership in the steel industry because they offer 98 to 99% efficiency, non-explosive collection, extremely low maintenance. In addition, no critical controls are required to maintain efficiency.

Chemico gas scrubbers are widely used for blast furnaces, and they are ideally suited for open hearth furnaces, cupolas, scarfing operations, sintering operations and electric furnaces.

For further information and your copy of a bulletin giving full particulars, contact Chemico . . . Gas Scrubbers Division.



Typical Flow Sheet for 60 Ton Converter

CHEMICO

CHEMICAL CONSTRUCTION CORPORATION
525 West 43rd Street, New York 36, New York

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successively as secretary, vice president—sales, and executive vice president. He was elected president in 1953. Mr. Berglund has been a director since 1947. In 1955 he was elected executive vice president. He joined Torrington in 1927, was named general works manager in 1945, and was elected vice president in charge of manufacturing in 1946. Mr. Dunlap joined the company in 1940 and has been a director since 1956. Elected a vice president in 1957, he was transferred last August to Torrington from the Bantam Bearings Division in South Bend, Ind., where he served as vice president and general manager.

Floyd P. Woumans has been appointed chief piping engineer of Auburn and Associates, Inc. Mr. Woumans was formerly chief engineer in the industrial design department of Blaw-Knox Co., power piping and sprinkler division, for 8 years.

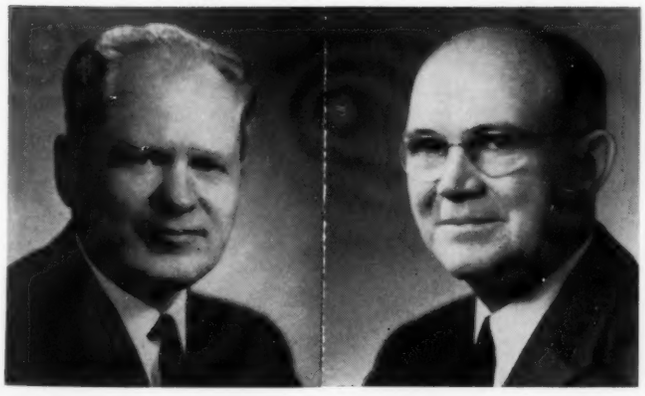
A. H. Fosdick, superintendent of Bethlehem Steel Co.'s Bethlehem, Pa., blast furnace division, has retired after 45 years of service. Mr. Fosdick joined Bethlehem in 1913. He was appointed assistant superintendent of the blast furnace department in 1919, and superintendent in 1928.

J. Paul Maddox has been appointed to the newly-created position of manager of market research and development of Mexico Refractories Co. Mr. Maddox has previously acted as special representative. Before joining Mexico Refractories in 1954, Mr. Maddox was associated with the Laclede Christy Fire Brick Co. as vice president in charge of the Laclede Arch Co. in Chicago, Ill.

John R. Anderson has been appointed manager of the Materials Handling Division of Heppenstall Co. Mr. Anderson joined Heppenstall in 1953. He became manager of engineering for the Materials Handling Division in 1954 and was named assistant general manager in May, 1958.

Thomas F. Scannell has been appointed vice president—general sales manager of The Falk Corp. General sales manager of the company since 1943, Mr. Scannell joined Falk in 1928 as manager of the St. Louis office. Previously, he had spent nine years with Chain Belt Co. In 1933 he became manager of the Southwestern district with headquarters in Dallas. He went to Milwaukee in 1940 as assistant to the sales manager. The following year he became sales manager and in 1943, general sales manager.

J. R. ANDERSON T. F. SCANNELL



Obituaries

GEORGE H. SCHAEFFER

George H. Schaeffer, former president of the Association of Iron and Steel Engineers, and superintendent of Electrical Maintenance and Engineering at The Carpenter Steel Co., died December 11. He was 76.

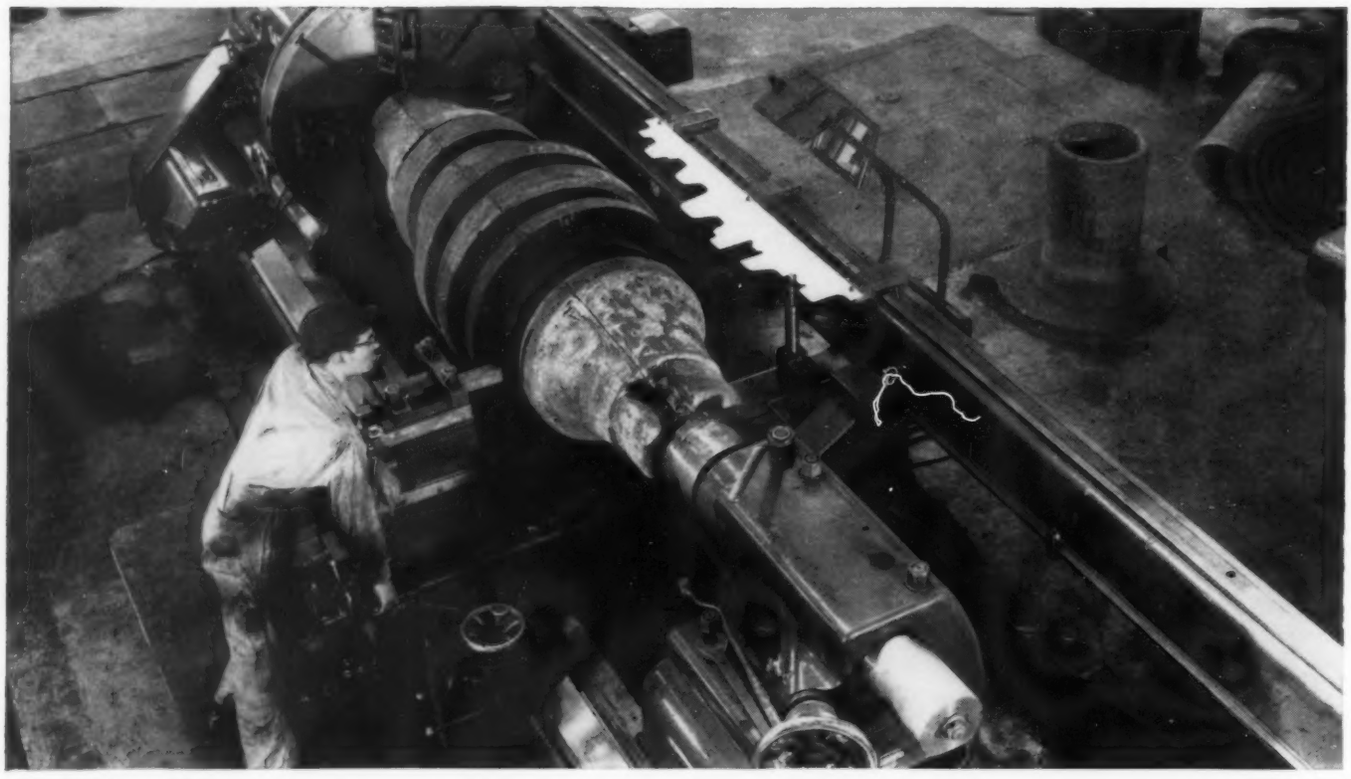
Fred E. Kling, 80, a former chief engineer at Carnegie-Illinois Steel Corp., died November 24. Mr. Kling spent 43 years with Carnegie-Illinois, retiring in 1945.

James F. Hanihan, superintendent hot mills, Acme Steel Co., died December 29.

Robert A. Gillies, 70, former vice president of the Steel Co. of Canada, Ltd., died November 26. He joined the company in 1928 as superintendent of the blast furnace department. He later held the positions of assistant works manager, and works manager before his appointment as vice president in charge of manufacturing in 1947. He retired from the company in 1953.

PROGRESS IN ROLL MAKING

contour turning of iron and steel rolls

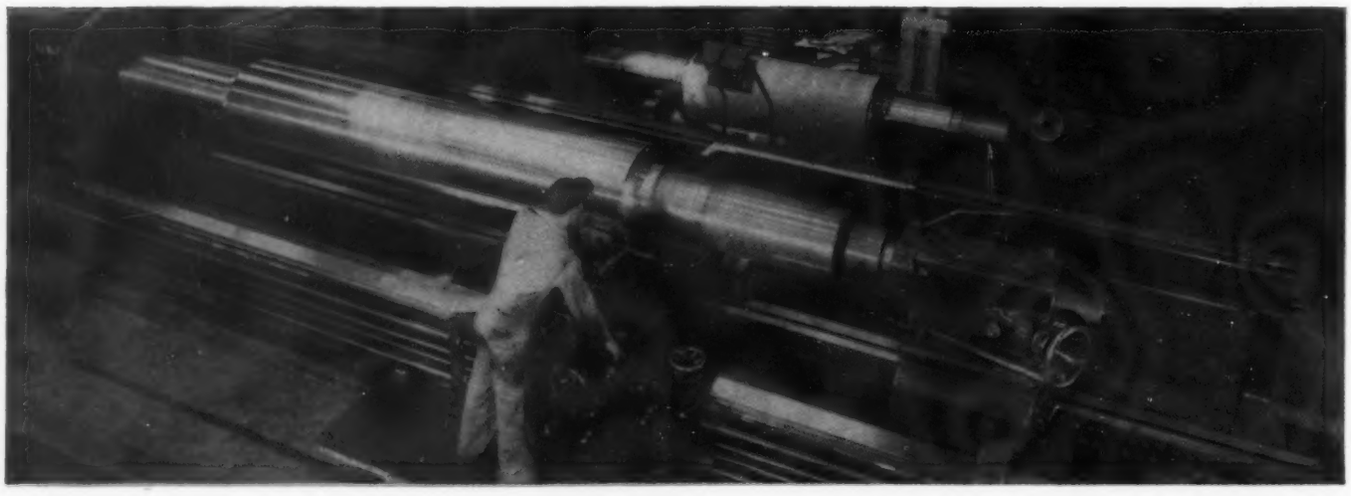


NEW—

THIS MODERN CONTOUR LATHE, one of the largest made—50″ x 24′—is the latest addition to the roll shop at National. Equipped with a complete hydraulic contour attachment, this lathe machines the largest rolls, accurately and quickly to exact specifications.

Plant expansion and new equipment are the keynote at National—all planned to give you better iron and steel rolls—when you need them and for all rolling mill operations.

GENERAL STEEL CASTINGS CORPORATION
National Roll & Foundry Division
Avonmore (Westmoreland County) Pennsylvania
General Steel Castings Corporation: General Offices, Granite City, Ill.
Plants: Granite City, Ill.—Eddystone, Pa.—Avonmore, Pa.



HAGAN NEWSLETTER

Behind the Panel

HOW AUTOMATIC ARE AUTOMATIC CONTROLS?

The answer depends a lot on the reliability factor in the system, and on how well the various control elements are integrated. A great many control systems are designed to operate on full automatic only when the process is within normal operating range. In applications where the process can vary widely, or where operators must be relieved of control supervision during abnormal conditions, true automatic control is desirable. Hagan systems are designed to accomplish this; for example:

OUTDOOR BOILER CONTROL SYSTEM STAYS ON AUTOMATIC DURING GENERATOR TRIP-OUT: a new outdoor utility station in the Southwest experienced a generator trip-out, and in the excitement, the 3-element feed-water control system was left on automatic. Inspection of charts after the difficulty was overcome showed that the feedwater system had maintained proper drum level throughout the two hour shut-down, even though the system went through the complete shut-down, start-up cycle.

SOAKING PITS NEVER OPERATED ON MANUAL CONTROL: on a new installation of two batteries of 3 pits, the heaters are instructed never to operate on manual control. In case of control malfunction, the pits are shut down until the system is repaired. In a year of operation, this policy has resulted in the loss of only four pit hours production time. Pit bottoms have not built up excessively, indicating close control of combustion and absence of ingot washing. (Item A-1)

FIRST SOLID STATE ELECTRONIC BOILER CONTROL SYSTEM

Operational magnetic amplifiers, used as basic control elements in the combustion, feedwater, pump recirculation and steam temperature control systems, will be installed on a new 1,260,000 lb/hr boiler at a Southern utility. The Hagan proposal--for the first solid state electronic boiler control--was selected by the utility in competition with two other electronic systems that did not achieve the reliability inherent in a solid state system. (Item A-2)

ELECTRONIC TEMPERATURE CONTROLLER SENSES 0.000001 VOLT CHANGE

Ultrasensitive, the Hagan PowrAmp Temperature Controller is responsive to thermocouple output fluctuations of one-millionth of a volt. Designed for precise temperature control in situations where either the heater or the product temperature can change rapidly, the Controller provides adjustments for proportional band, reset, and rate action. While this is a new instrument, it has already been proven in action. It was selected for the critical job of controlling glass fiber drawing dies operating at 1600F and it is limiting die temperature fluctuation to less than 0.25F. The Controller provides stepless regulation and will handle up to 330 kva through saturable reactors. (Item A-3)

NEW POWRLOG OFFERS LOW-COST TEMPERATURE MEASUREMENT OR CONTROL

Our systems engineers wanted a rugged, low-cost remote recorder for process measurement in industrial applications. Once we decided that the right way to minimize maintenance was to make use of unitized construction, the acorn we had been asked for rapidly became a full fledged oak. We ended up with an instrument that will measure any function that can be converted into an error voltage, either AC or DC, and then convert these voltages into mechanical movement that may be used for driving a recorder, indicator, integrator, pneumatic transmitter or a controller.

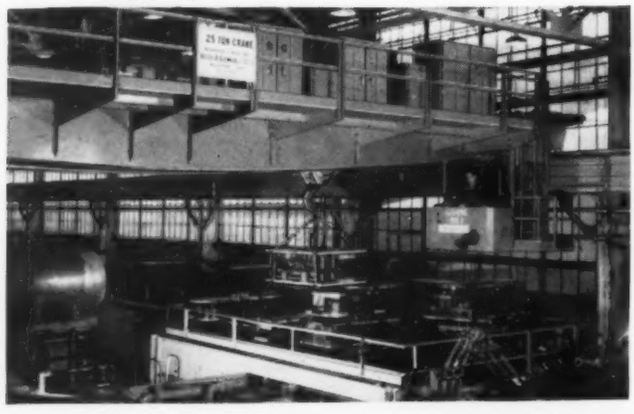
Utilizing a unique amplifier that is adaptable to a wide variety of applications by means of plug-in input boxes, the new HAGAN PowrLog is particularly well suited for the remote measurement and/or control of temperature with either thermocouples or resistance bulb thermometers. The components of this versatile instrument have been selected for accuracy and high reliability--result--maintenance has been reduced to a new low. (Item A-4)

HAGAN CHEMICALS & CONTROLS, INC.
Hagan Building, Pittsburgh 30, Pa.

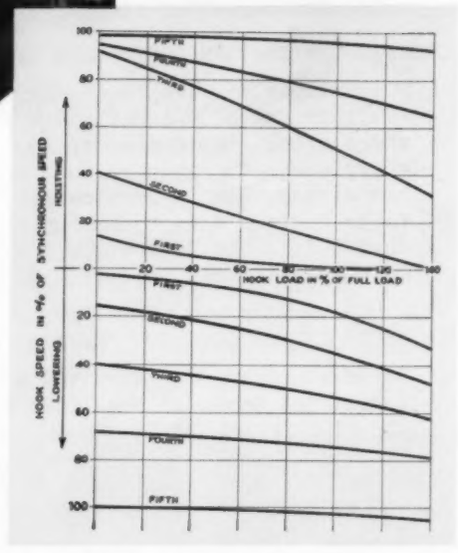
If you would like more information on any of the above items, check the appropriate box below.

☐ Item A-1 ☐ Item A-2 ☐ Item A-3 ☐ Item A-4

Here's Why Men in Command Specify



25-ton crane, equipped throughout with EC&M Control, gives excellent results in handling dies in automotive plant



Hook-speed curves tell the story! Nearly flat curves, regardless of load. Braking torque regulated from the simplest of magnetic amplifiers. No costly electronic tubes or complicated bias control involved

THE ELECTRIC CONTROLLER & MFG. CO.

A DIVISION OF THE SQUARE D COMPANY

CLEVELAND 28 • OHIO

EC&M EDDYMAG* A-C Crane Control

ALL LOWERING SPEEDS SAFE because braking torque is automatically adjusted. Any tendency for the motor to speed up increases the eddybrake torque to insure safe lowering of all loads.

FAST RESPONSE enables the operator to "inch" loads accurately. Speed regulation is excellent, too. On first point, the empty hook starts down and the same point provides slow speed for "inching" heavy loads.

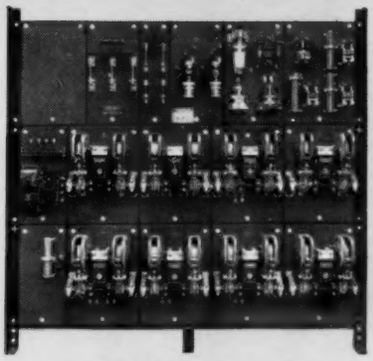
EASIER MAINTENANCE • All EC&M components are standard, mill-type construction—familiar to maintenance men, simple to work with, easy to understand.

SIMPLE CIRCUITRY • "EDDYMAG" Control uses no sensitive circuits—no tubes to balance. EC&M Frequency Relays, operating from the slip frequency of the motor, provide crane performance unequalled by other methods. Only one plugging relay and one set of acceleration relays required for smooth operation of the a-c wound-rotor motor-driven crane.

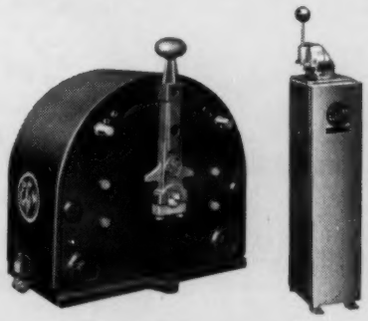
Join the men who know performance—specify EC&M Control for your next crane. For complete facts, write for Bulletin 6400

*EDDYMAG is an EC&M registered trademark

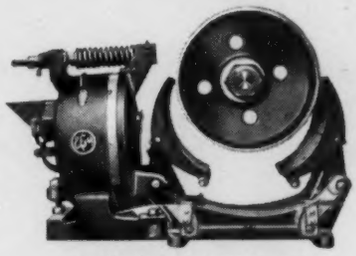
EC&M PERFORMANCE-PROVEN EQUIPMENT FOR CRANES



EC&M EDDYMAG Hoist Control uses mill-type contactors and relays—off-point braking helps stop the load



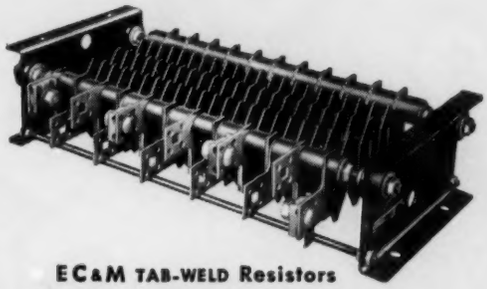
EC&M Master Switches—Cam or Vertical types—are compact, easy to operate



EC&M Type WB Brakes—100% lubricated—dirt can be flushed out

EC&M Manual-Magnetic Disconnect Switches provide a safe and convenient means for "killing" the crane

EC&M Youngstown Safety Limit Stops prevent over-hoisting accidents



EC&M TAB-WELD Resistors eliminate burning at the grid eyes and at the tap plates

9812

ALLIANCE has long been recognized as the "World's largest builders of the world's largest cranes". But size doesn't automatically answer a customer's needs.

ALLIANCE meets customer's capacity requirements with skillful engineering, and absolute minimum of downtime and maintenance.

Look to ALLIANCE for greater overall return for your investment.

Regardless of size or capacity, for economy of operation, ALLIANCE LEADS THE WAY.

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machine company
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Equipment News...

FLAME CUTTING POWDER

△ A unique flame-cutting machine has been operating effectively at Pittsburgh Steel Co.'s, Allenport, Pa., plant. Key to the efficiency of this machine is the addition of special Oxweld iron powder to the oxygen cutting flame.

Operation is entirely automatic and more than 1000 billets are cut every eight-hour shift. Billets 3½ to 7½ in. in diam are sliced into lengths ranging from 4 to 12 ft. Materials cut vary from mild steel, through tough high carbon, to 4 to 6 per cent chrome alloy. Cuts are made fast, clean and sharp and require no finishing. After billets are "tailor" cut they are fed into seamless tube hot mills to be made into tubing which varies from 2⅜ in. O.D. to 8¼ in. O.D.

Powder-cutting replaces the use of shears for this work. In addition to increasing the over-all speed of the operation, powder-cutting also prevents elliptical shaped ends which are a problem with shearing. Shearing also has a tendency—especially in harder steels—to produce cracks that show up as open seams in finished tubing. This problem is also eliminated with powder-cutting.

Two Linde Oxweld C-39 cutting torches with powder-cutting attachments are mounted on an Oxweld CM-37 machine carriage that automatically controls the cutting speed. Cams ride on the surface of the billets and raise and lower the torches to follow the round surface. Oxweld No. 200 iron powder is fed into the cutting oxygen stream from an Oxweld D-9 pneumatic powder dispenser. The addition of powder produces the intense reaction that gets the cuts on the round surfaces off to a flying start. Use of powder also allows the operator to quickly pick up the cut if for any reason the machine should be stopped at any point in its cycle.

An operator easily and accurately controls the machine from a booth containing all necessary controls. Pushbutton control makes it possible to automatically raise or lower the track for different size billets, position the torches at any place in the cycle, and restart the cut if lost. Billets are delivered by a crane to the cutoff dock where an operator rolls them onto the loading table and sets the stop for the required length. Sections are rolled from the cutting machine onto a platform where a skip car picks them up and transfers them to bins. The crane delivers them to the preheat furnaces and then to the hot tube mills.

Over-all view of the automatic billet cutting setup shows the loading dock, feed rolls, cutting table and the control booth on the right. Oxweld iron powder is fed into the flames from the Oxweld D-9 injector on the platform to the upper left of the machine.

CONVEYOR IDLER

△ Developed by Hewitt-Robins, Inc., is a new spiral-shaped rubber idler for belt conveyors to handle coal, ores, coke, aggregates, cement and other bulk materials.

The idler, highly flexible and adaptable to any type of belt conveyor, is made of tough synthetic rubber molded around a wire rope. Although smaller in diameter and lighter in weight than conventional all-metal idlers, it carries the conveyor belts which ride over it smoothly and efficiently under either heavy or light loads.

Its principal advantages are as follows:

(1) Self-cleaning action produced by constant flexing from end-to-end prevents build-up of wet, sticky materials.

(2) Flexibility enables it to readily conform to variations in the belt load, thus providing more uniform conveyor operation.

(3) Mounting brackets on either end of the idler permit free pivot in the vertical plane with the result that the idler hangs naturally and conforms readily to off-center loads.

(4) Replacement is easily accomplished by simply lifting out worn idlers and dropping in new ones without removal of bolts, frames or other holding devices.

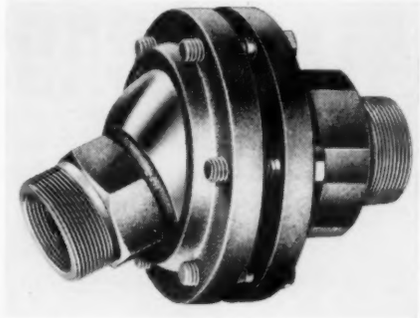
(5) Intrusion of dirt into moving parts is prevented by newly-developed seals.

(6) Torsional strength resulting from the continuous rubber spiral insures long life and reduces internal twisting and the breaking loose of individual discs or rolls that are used on some idlers.

The idlers will be available for belt widths of 18 in., 24 in., 30 in. and 36 in.

ADJUSTABLE JOINTS

△ Three new, large size adjustable joints have been added to the Spraying Systems Co. line, for use in spray nozzle installations where variable angular adjustment of the nozzle is desired. These new adjustable joints are for large capacity



nozzles with 1½-in., 2-in. and 2½-in. NPT connections.

Ball joint design permits positioning at any point over a 40-degree included angle and 360-degree rotational range. With these new products, Spraying Systems now offers

adjustable joints in all sizes from ¼ in. to 2½ in.

FLAT FLAME BURNER

△ A new burner that distributes heat uniformly at right angles to burner centerlined is announced by the North American Mfg. Co. Local hot spots in front of the burner have been eliminated by producing a flame without forward velocity. This flame, heats a large area of the furnace wall behind the burner without the aid of impingement baffles or any other high-maintenance heat distribution device. There are no metal parts within the burner tile exposed to excessive heat—the nearest metal is set back nine in. from the furnace chamber.

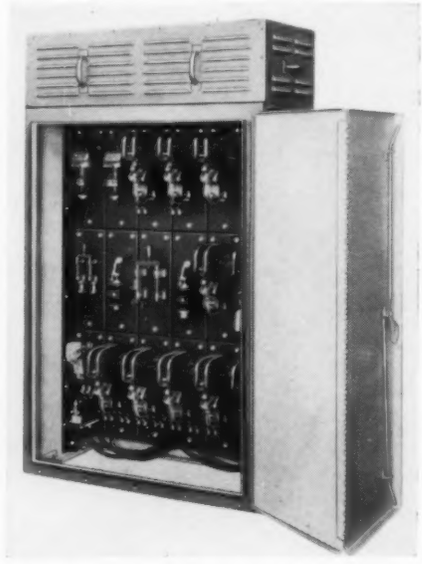
The series 4832 Flat Flame Burner is a nozzle mix gas burner offered in six sizes with air connection ranging from 1¼ in. to 4 in. pipe size. Burners operate on 12 to 16 psi air pressure at high fire, with capacities of 234,000 to 2,620,000 Btu/hr at 16 psi. The burner is lighted easily with a pilot.

The burners are designed for use on direct fired cover annealing furnaces, galvanizing kettles, and other applications where it is advantageous to place the burner close to the work to heat large areas uniformly without getting flame impingement or hot spots.

HOIST CONTROLLER

△ A new crane hoist controller—the Form HWR—has been developed by the Electric Controller & Mfg. Co., Division of Square D Co., to provide the advantages of d-c performance on a-c cranes.

Highly efficient silicon rectifiers are used to supply d-c power to a



series-wound hoist motor and its series-wound brake. The inherent "blocking" characteristic of the silicon rectifiers automatically increases the motor stability for safe lowering of extreme overloads. The compact rectifier units are mounted on top of the controller.

The circuit used in the new HWR controller is the Wright dynamic lowering circuit, which combines simplicity and safety with reliable performance. Positive over-hoisting protection is provided by Youngstown limit stops. Load-retarding and load-indicating devices mounted on the trolley are unnecessary.

CRANE SPREADER BEAM

△ Several unusual crane spreader beams with power-driven rotating "C" hook have been completed by The Cleveland Crane & Engineering Co., for handling ingots and heavy steel slabs.

ATLAS CARS

Custom-built to the needs of each customer, Atlas Cars assure the dependability that maintains haulage schedules.

Since 1896 designers and producers of Ore Transfers . . . Scale Cars . . . Coke Quenchers . . . Coal Larries . . . Door Machines . . . Safety-Type Transfers . . . Storage Battery Locomotives

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78th year

For over three-quarters of a century PECor has been a leader in the production of quality steel plant equipment. Many of the improvements in furnaces, converters, mixers and materials handling equipment of all kinds commonly found in steel plants today were pioneered by PECor. This background, coupled with our present modern facilities and a skilled engineering staff, makes PECor especially qualified to work with you on all your requirements.

Our 40-page catalog—available on request—will help you visualize how we can serve you best.

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REBUILDING—*a specialty!*

good for another 50 years... it's a Green fan!

We had a phone call the other morning. Nothing unusual about that—people do call us. This caller said he had an old Green fan, and wondered if we'd care to look it over. Figured we might have a buyer for it.

Well, it turned out that this was one of our earliest fans, the sixth fan we made, in fact. Every bit of it, fan, shaft and housing, was designed and made in our plant in 1903. Now, 1903 is so long ago even the name of our town has since been changed from Matteawan to Beacon.

For 55 years this Green fan had been used in a lumber mill for exhausting shavings from a planer. The building in which the fan was housed was torn down early in 1958. Everything but this Green fan had been carted away.

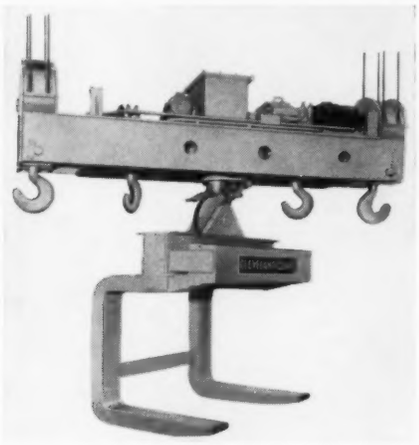
We went over that fan inch by inch, and bought it for ourselves to keep as an example of Green's workmanship.

Know something? It could be started up today, with no repairs, and we feel it would run satisfactorily for another 50 years. Just goes to show when Green builds a fan, well—it's built!

Green

THE GREEN FUEL ECONOMIZER CO., INC. BEACON 3, NEW YORK

Each spreader beam has five hooks. The center hook may be rotated without limit in either direction by a motor drive working through reduction gearing mounted on top of the beam. A slip device is used to prevent damage to the drive. The two hooks next to the center may be rotated 360 deg manually. The end hooks cannot be turned; however, because they are mounted on pins,



they may be rocked. All hooks except the middle one are rated 20 tons capacity.

The center hook is used primarily to support a special "C" hook which has a live load capacity of 30 tons. The hook is easily attached or detached. It is counterbalanced to keep it level. The supporting hook has a safety latch which prevents the "C" hook from coming off accidentally.

The lifting prongs of the "C" hook will handle a stack of slabs with a cross section of 4 ft 0 in. wide and 4 ft 0 in. high.

CENTRIFUGAL SWITCH

△ The Euclid Electric & Mfg. Co. announces a new Bulletin 2210 centrifugal switch with an over-all adjustable speed range from 70 to

5000 rpm, and the operating speed adjustable while the switch is running.

Measuring only $7\frac{3}{4}$ in. long by $3\frac{9}{16}$ in. high by $3\frac{3}{4}$ in. wide, the type C switch is housed in an enclosure molded of tough glass fibre reinforced polyester resin. The result is a rugged enclosure that withstands severe shock impacts and that is resistant to acid, alkali, salt compounds and moist corrosive atmospheres.

Two separate sets of contacts can be adjusted for operation at different speeds so that two separate operations can be controlled from one speed-sensitive switch. Therefore, it is possible to perform two different functions at two different speeds.

Permanently lubricated, the Type C requires no periodic maintenance.

TRUCK TRANSMISSION

△Hyster Co. announces a new dual-range, power shifted Hystamatic transmission as optional equipment for the new Challenger 60, 70, and 80 pneumatic-tire lift trucks in the 6000-8000 lb capacity range.

The new transmission is a hydraulically shifted, constant mesh unit with integral torque converter. The two ranges forward and two in

SUPERIOR
CARBON
BRICK
FOR

◀ Blast furnace linings
◀ Blast furnace run-out troughs
◀ Cupola linings
◀ Steel pickling tanks

Standard sizes and shapes • Tested performances
Competent technical service • Superior chemical and metallurgical characteristics • Graphite brick also available.

May we give you a quotation?

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GREAT LAKES CARBON CORPORATION
18 EAST 48TH STREET, NEW YORK 17, N.Y. • OFFICES IN PRINCIPAL CITIES

25-Ton, 72-ft. span Bedford Crane over the mold yard in Detroit Steel Corporation's new mill at New Boston (Portsmouth), Ohio.

Bedford Cranes continue to gain favor with steelmakers

Repeat orders tell the story: in steel mills, power plants, throughout heavy industry . . . wherever superior performance is demanded . . . men who know equipment are re-ordering Bedford Cranes.

For these men know from experience that Bedford Cranes — backed by over a half-century of specialized crane building and utilization experience — will deliver consistent top-notch performance through the years. They know every advanced design feature of a Bedford Crane will pay off in safer, smoother, more dependable operation—and they know that every Bedford Crane installed in their plant will be individually engineered and precision built for its specific application.

You are invited to consult a Bedford Engineer on your next crane problem . . . with all the facts on the table, we believe you too will make *your* next crane a Bedford . . . available in all types and sizes, from 5 to 350 tons and up—for all kinds of indoor and outdoor service.

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CM Hammerlok®
COUPLING LINK

• *MADE BY* the makers of Herc-Alloy... the original alloy steel chain.

CM HOISTS AND CHAIN

COLUMBUS McKINNON
CHAIN CORPORATION
TONAWANDA, NEW YORK
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reverse are operator selected by means of levers. All components are confined in a single housing mounted to the engine as an integral part of the power train.

Simple movement of selection levers hydraulically shifts the transmission into forward or reverse, high or low range. The torque converter automatically adjusts power output to fit road and load conditions within each range. As a result, the engine runs at its most efficient speed, reducing engine wear and prolonging engine life. Action of torque converter absorbs shock loads on shafts, bearings, gears, and axles, extends truck life. Forward-reverse power shift permits effortless "on the fly" change of direction.

Inching is controlled by the left foot with a combination inching and braking pedal, leaving right foot free to maintain engine speed for fast lifting.

GAS-AIR BURNERS

△For accuracy in localized heating operations, Selas Corp. of America, announces an improved and enlarged line of Multiport P-R gas-air burners that combine positive flame geometry with maximum heat release and low turndown.

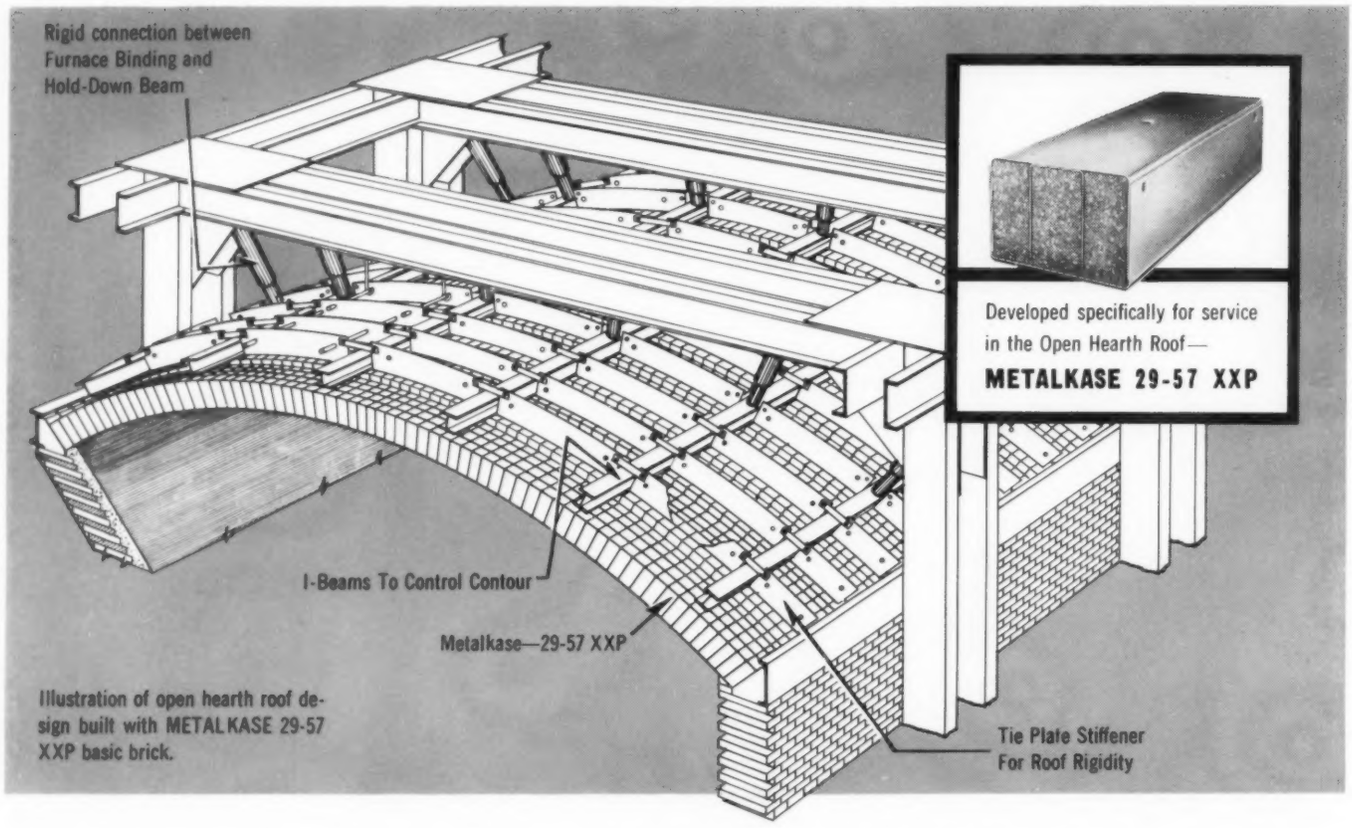
The wide operating ranges of the precision-built burners with any commercial fuel gas permit their effective use for a great number of applications, such as: high temperature alloy brazing, glass fire-polishing and forming, heat treating materials, heating solder pots, etc.

Efficiency is made possible by the design of the burner's multiport refractory screen, which is die-formed under high pressure, using selected high grade ceramic materials. The screen breaks up the flame front into a large number of small flames—concentrated "flat face" round flames of high intensity—and it cannot warp, scale or corrode in the severest service.

Additional advantages of the low cost burners are: screen port diameter/length ratio inhibits flashback, even at extremely low input rates; pilot ring resists scaling and corrosion, and screws onto burner, eliminating need for special lock pins or costly "one-piece" construction; interchangeability of components facilitates quick and easy replacement of parts.

With Harbison-Walker Refractories

LONGER SERVICE and INCREASED TONNAGE in the ALL-BASIC open hearth


Rigid connection between Furnace Binding and Hold-Down Beam
Developed specifically for service in the Open Hearth Roof—
METALKASE 29-57 XXP
I-Beams To Control Contour
Metalkase—29-57 XXP
Illustration of open hearth roof design built with METALKASE 29-57 XXP basic brick.
Tie Plate Stiffener For Roof Rigidity

Accelerated progress in open hearth steel furnace practice involving larger furnaces, increased use of oxygen and higher rates of production creates demands for superior refractories. With the all-basic open hearth furnace becoming an economical reality, the development of new refractories having decidedly enhanced properties has been necessary. Harbison-Walker conventional and specialized basic refractories are meeting these requirements and winning widest approval.

A fundamental development in the achievement of the all-basic furnace is the metal encased basic brick pioneered more than forty years ago by Harbison-Walker. Through constant research and extensive application experience, rapid evolutionary progress has resulted in the successful use of the metal encased basic brick for open hearth roofs, as well as for other furnace parts.

METALKASE 29-57 XXP internally plated metal encased basic brick is used in both sprung and suspended open hearth roof constructions of all designs with unmatched service records. An exceedingly important contributor to the excellence of this refractory, developed specifically for the purpose, is the high purity magnesia produced by Harbison-Walker from Michigan brines. Fully stabilized as periclase of high density, it is an important constituent of this refractory having outstanding properties for the particular application.

The successful use of basic brick for roofs contributes to greater severity of conditions imposed upon other furnace parts. Harbison-Walker basic refractory products long established with excellent records, together with the newer specialized brands fulfill these rigid requirements for bottoms—walls—and regenerator checkers and make **THE ALL-INCLUSIVE, ALL-BASIC** Open Hearth Steel Furnace a reality.

HARBISON-WALKER REFRACTORIES COMPANY
AND SUBSIDIARIES — GENERAL OFFICES: PITTSBURGH 22, PA.
World's Most Complete Refractories Service

Book Reviews

"Arc Welding in Machinery Design and Manufacture" has been recently published by the James F. Lincoln Arc Welding Foundation, Cleveland, Ohio. The book contains 209 pages, 6 x 9 in., is clothbound and sells for $2.00 in the U. S. A., $2.50 elsewhere. This is a reference manual of ideas for the efficient use of steel in machine design. It supplies answers to many common problems in machine design and manufacture and suggests ideas whereby further improvement can be made in present design through the application of arc welding. The work is divided in two parts: Part I is a brief description of the inherent advantages in the use of steel in welded design, and gives suggestions as to what must be considered in good welded design. The section may be used as a check-off list to help assure that the possibilities of steel for greater strength, stiffness and comparative lower costs have been fully realized. Part II contains a series of case histories describing methods by which industrial problems in design and manufacturing have been solved using welded construction. The majority of the case histories are taken from papers presented in three recent award programs of the Foundation, and although some of the designs have been changed or even discontinued, they are presented as being basically sound solutions.

"The Physical Chemistry of Steelmaking," edited by John F. Elliott, has been recently published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. The book contains 257 pages, 8½ x 11 in., is clothbound, and sells for $15. The book contains the proceedings of the conference on the physical chemistry of iron and steelmaking, sponsored by the Department of Metallurgy, Massachusetts Institute of Technology, and the papers contained cover a diverse group of topics of recent origin summarizing the thinking of a number of leaders in the field of metallurgy. Also included are the results of recent fundamental research and applications of such research to current technical problems. The presentation is in nine sections: liquid metals and properties of solutes in liquid iron and steel; equilibria of reactions in liquid iron and steel; behavior of metal oxides and of components of iron and steelmaking slags; slag-metal equilibria in blast furnace and steelmaking furnace systems; kinetics and slag-metal reactions; reaction rates in iron and steelmaking processes; application of fundamental data to process development and metallurgical problems in the steel industry; solidification of castings and ingots; research planning. Forty-two papers are included and in addition a special lecture on kinetic problems in steelmaking. Line drawings, scales, equations, graphs and photographs are used to illustrate the text.

"Purchasing Handbook," George W. Aljian, editor-in-chief, has recently been published by the McGraw-Hill Book Co. Inc., 330 West 42nd Street, New York 36, N. Y. The book contains 1392 pages, 6 × 9 in., is clothbound and sells for $15. This is the work of 220 contributors and a unified, thorough and authoritative handbook of purchasing-department organization, management and procedure. It includes a wealth of facts, principles, methods and data covering the purchasing routine, rating vendors, buying economically, control inventory, preparing contracts and forms, etc. Buyers for government, institutional, and other nonprofit organizations as well as for business and industry will find pertinent data. Reference materials including 80 types of commonly used forms, scores of tables and charts, examples of reports, department manuals, letters, contracts, and a glossary of terms and symbols are covered. This handbook presents a very thorough covering of the subject of purchasing and a few of the topics included are: basic price considerations involved in any purchase; whether to make or buy materials and supplies; how to reduce costs in materials, supplies, and services; things to look for in buying 16 general classifications of commodities; examples of "Conditions of Transportation" forms; handling sales of scrap and other salvage materials; and purchasing department budgets.

HEIL of Cleveland

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VENTILATING SYSTEMS

for Corrosive Fumes

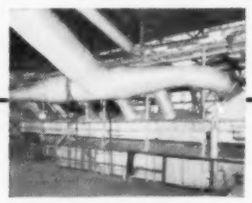
—NOTHING TO RUST—

Complete facilities including fume collecting hoods—fume ejectors—ducts—centrifugal and axial fans—fume scrubbers and stacks. Our proven, corrosion free, Rigivin (rigid vinyl) and Rigidon (reinforced plastic) construction assures a maximum of long, efficient operation. There is **nothing to rust.**

Wide range of standard units speeds delivery, and minimizes your engineering costs.

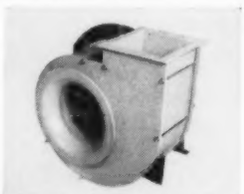
Let the Heil Corrosion Engineers, with 29 years of experience, survey your needs, recommend the equipment that will provide utmost efficiency, economy and long, maintenance-free operation.

Write for Fully Descriptive Bulletins.



Complete Solid Plastic Ventilation System for Handling Sulphuric Acid Fumes.

Scrubber, Fan and Connecting Duct Work Handling Nitric and H. F. Fumes.



Heil Model No. 20 Solid Plastic Exhaust Fan.

CHEMICAL PROOF LININGS · TANKS HEATERS PLASTICS

HEIL PROCESS EQUIPMENT CORPORATION

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POOLE Flexible Couplings

Look at these features—many of them exclusive with the patented POOLE:

Adjusts itself to all conditions, leaving its members free to float without strain to parts.

Geared type providing great strength, the highest efficiency of modern flexible coupling design.

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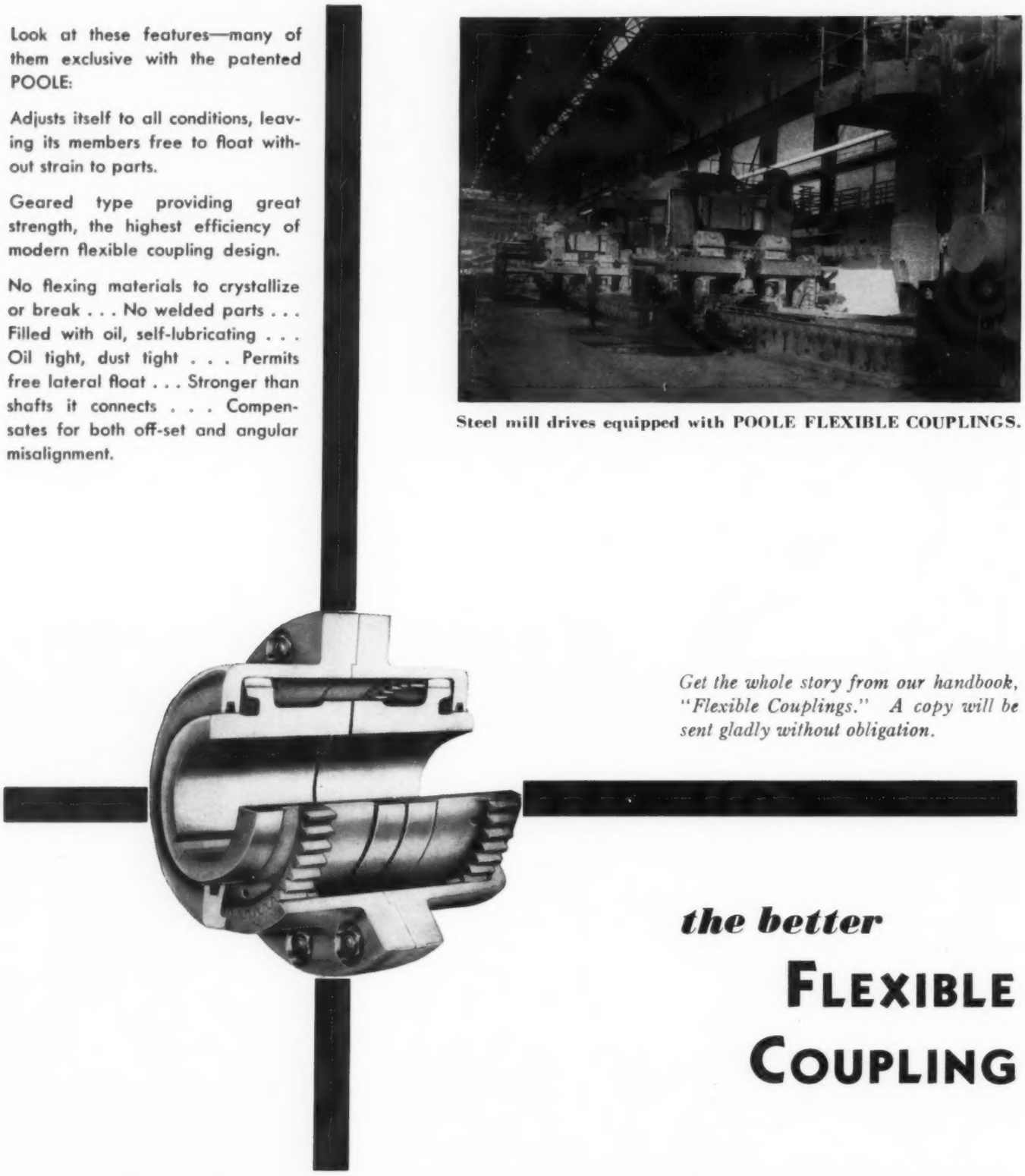

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INDEX TO ADVERTISERS

JANUARY, 1959

A

Aetna-Standard Engineering Co. 1
Alliance Machine Co. 190
American Messer Corp. 54, 55
Appleton Electric Co. 65
Atlantic Refining Co., The 44
Atlas Car & Manufacturing Co. 192

B

Babcock & Wilcox Co., The 14
Bailey Meter Co. 38
Bearings, Inc. 170
Bedford Foundry and Machine Co. 196
Berry Bearing Co. 23
Birdsboro Steel Foundry and Machine Co. 46
Bliss Co., E. W. 32
Bloom Engineering Co., Inc. 42
Bristol Co., The 60
Browning & Co., Inc., Victor R. 27

C

Chemical Construction Corp. 184
Clark Controller Co., The 5
Cleveland Crane and Engineering Co. 10
Cleveland Tramrail Div.,
Cleveland Crane & Engineering Co., The 41
Cleveland Worm and Gear Co., The Cover 3
Columbus McKinnon Chain Corp. 197
Cutler-Hammer, Inc. Cover 2, 36, 37

D

Dodge Manufacturing Corp. 62
Dowell 18
Dravo Corp. 6
Drever Co. 15

E

Electric Controller & Mfg. Co., The
Square D Co. 43, 188, 189
Electric Machinery Mfg. Co. 57
Elliott Co. 12, 13
Enterprise Co., The 168
Euclid Electric & Mfg. Co., The 161

F

Feller Engineering Co. 160
Frantz Co., Inc., S. G. 161

G

Garlock Packing Co., The 63
General Electric Co. 58, 59
General Steel Castings Corp.,
National Roll & Foundry Div. 186
Great Lakes Carbon Corp. 195
Green Fuel Economizer Co., Inc. 194

H

Hagan Chemicals & Controls, Inc. 187
Harbison-Walker Refractories Co. 198
Heil Process Equipment Corp. 199
Heyl and Patterson, Inc. 4
Hunt Valve Co. 40
Hyde Park Foundry and Machine Co. 197

K

Koppers Co., Inc. 52

L

Larco, Inc. 185
Leeds and Northrup Co. 45
Link-Belt Co. 28, 64

M

Mackintosh-Hemphill Div.,
E. W. Bliss Co. 49
Mesta Machine Co. Cover 1, 178
Minneapolis-Honeywell 8, 9
Morgan Construction Co. 165

N

National Carbon Co.,
Union Carbide Corp. 51
National Electric Coil Co. 204
National Roll & Foundry Div.,
General Steel Castings Corp. 186
North American Manufacturing Co. 169
Northern Engineering Works 182

O

Ohio Steel Foundry Co., The 166

P

Pangborn Corp. 162
Pannier Corp., The 161
Pennsylvania Engineering Corp. 193
Pennsylvania Transformer Div.,
McGraw-Edison Co. 66
Plibrico Co. 35
Pollock Co., William B. 53
Poole Foundry and Machine Co. 200
Post-Glover Electric Co. 181

R

Roberts and Schaefer Co. 175
Rust Furnace Co., The 159

S

Sel-Rex Corp. 19
Spraying Systems Co. 35
Stamco, Inc. 56
Surface Combustion Corp. 176, 177
Syntron Co. 173

T

Taylor Chain Co., S. G. 29
Texas Co., The Cover 4
Timken Roller Bearing Co., The 31
Torrington Co., The 33

U

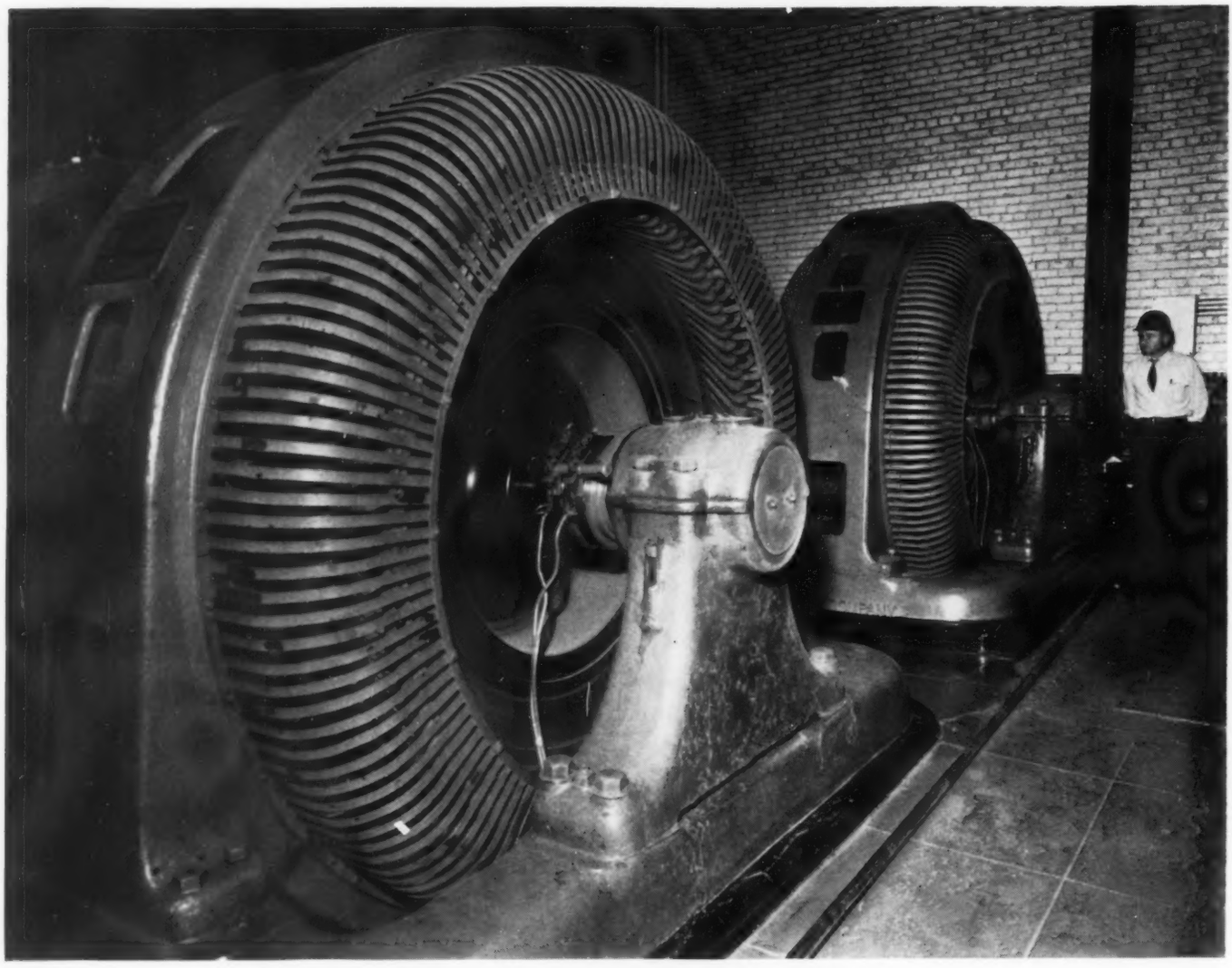
Union Carbide Corp.,
National Carbon Co. 51
United Engineering and Foundry Co. 17

W

Wagner Electric Corp. 16
Waterbury Farrel Foundry & Machine Co. 174
Wean Engineering Co., Inc., The 2
Westinghouse Electric Corp. 24
Wichita Clutch Co. 20
Wilson Engineering Co., Inc., Lee 7

Y

Yoder Co., The 39
Youngstown Alloy Casting Corp. 61
Youngstown Foundry and Machine Co. 34



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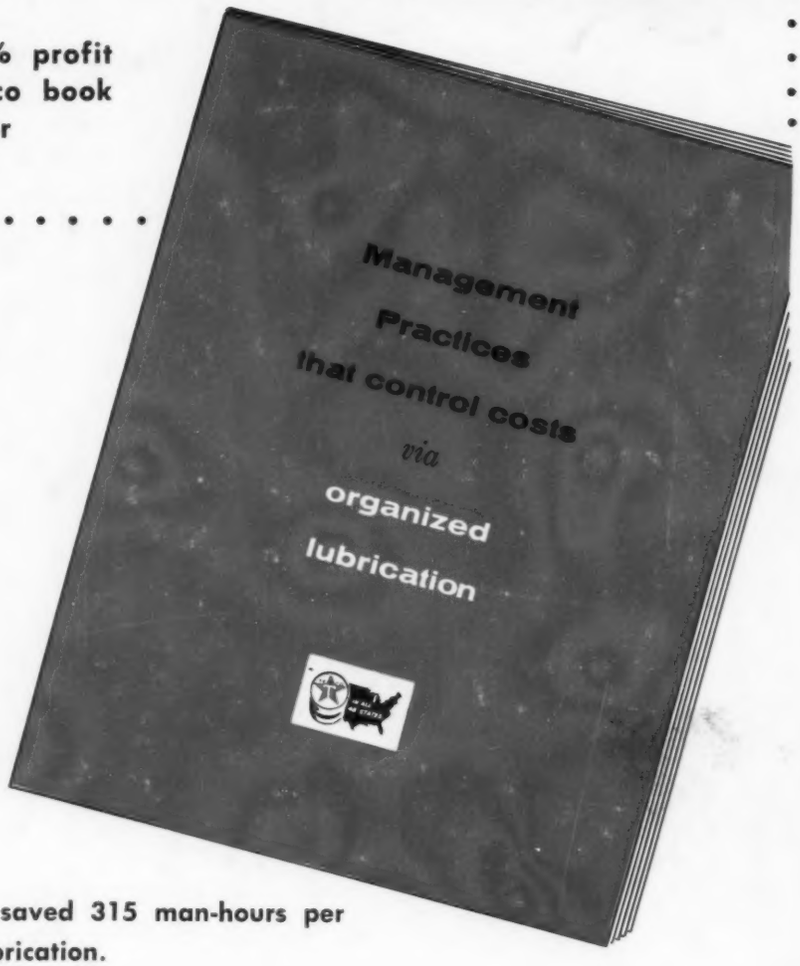

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